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Allen et al.

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(45) **Date of Patent: Sep. 20, 2016**

(54) **METHOD AND SYSTEM TO AUTHENTICATE MULTIPLE IMS IDENTITIES**

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(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Jun. 30, 2015**

(51) **Int. Cl.**

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H04W 76/02	(2009.01)
H04M 15/00	(2006.01)
H04W 12/06	(2009.01)
H04W 60/00	(2009.01)

(52) **U.S. Cl.**
CPC ***H04W 4/10*** (2013.01); ***H04M 15/57*** (2013.01); ***H04W 12/06*** (2013.01); ***H04W 60/005*** (2013.01); ***H04W 76/022*** (2013.01)

(58) **Field of Classification Search**
CPC H04W 4/02
See application file for complete search history.

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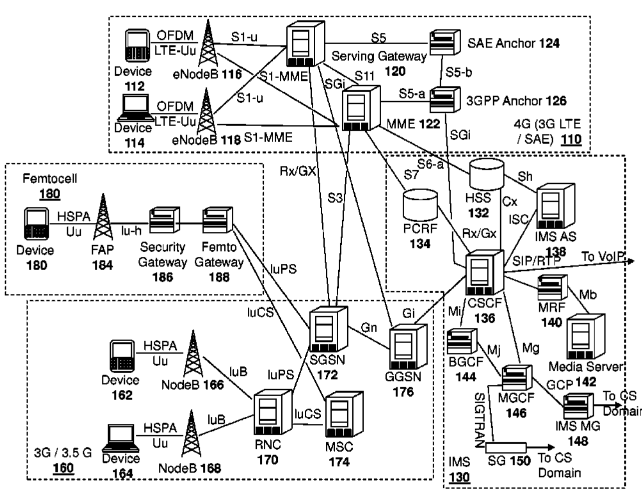
(Continued)

Primary Examiner — Michael T Vu
(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

A method and UE for registering with a third network node using IMS, the method creating a tunnel; authenticating a first public identity associated with the UE to the first network node; receiving configuration information with a second private identifier and a second public user identifier, and registering with a third network node using the second private identifier and the second public user identifier. Further, a method and first network node configured for authentication between a UE and a third network node using IMS, the method establishing a tunnel; authenticating a first public identity of the UE; receiving a configuration information message from the UE including a network identifier for a network the UE is registered on; obtaining, from a second network node, a second private identifier and second public user identifier; and providing the second private identifier and second public user identifier to the UE.

21 Claims, 20 Drawing Sheets



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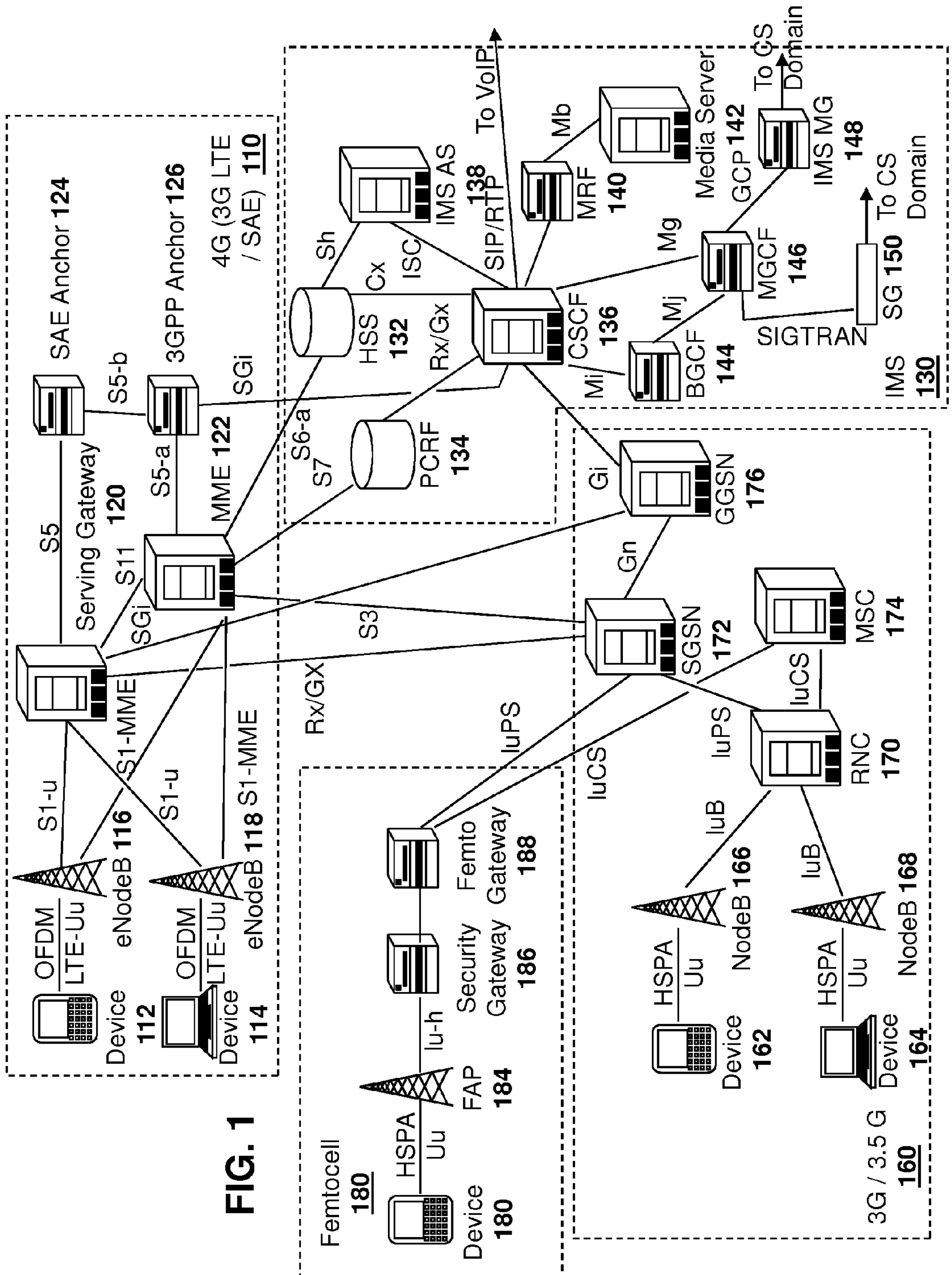
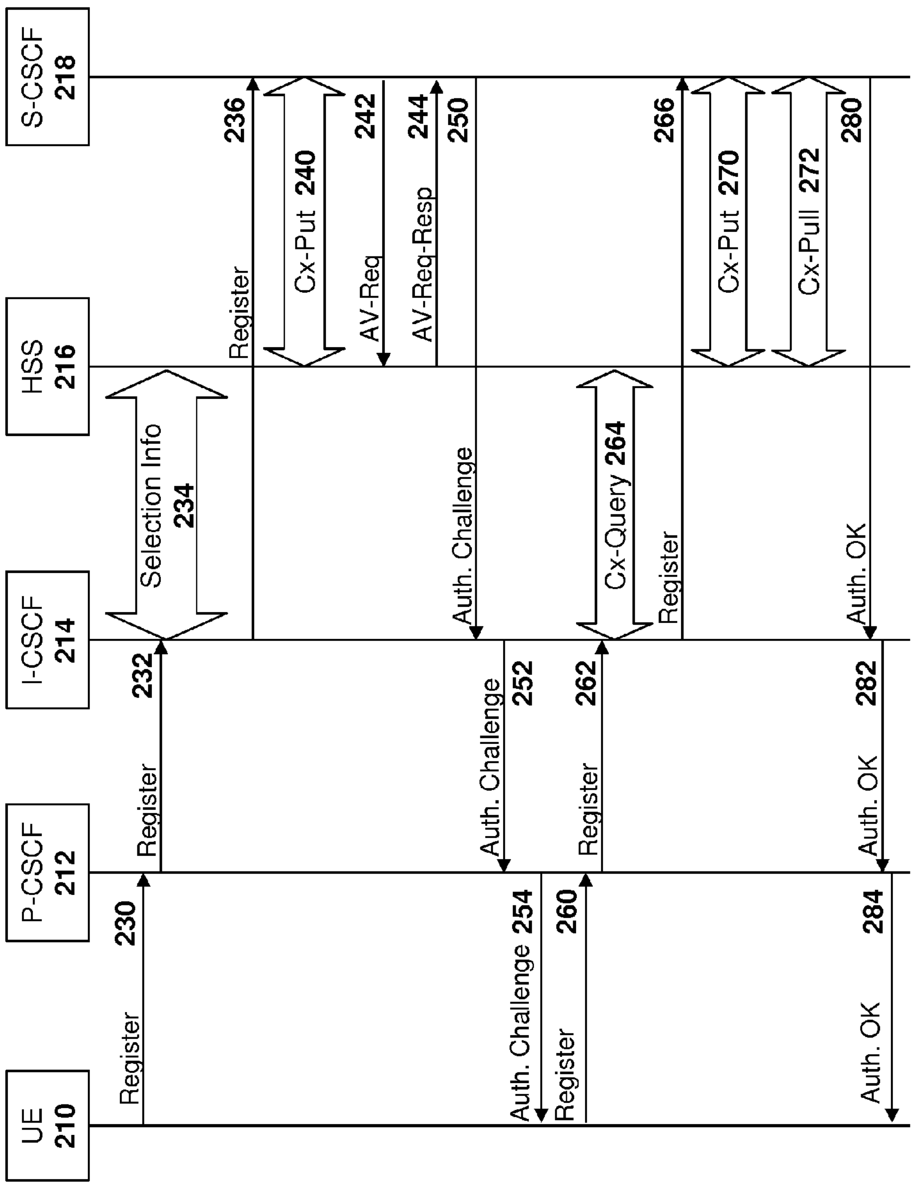


SAE Anchor 124
3GPP Anchor 126
4G (3G LTE / SAE) 110
Serving Gateway 120
MME 122
S5
S5-a
S5-b
S11
SGi
S1-u
S1-MME
OFDM
LTE-Uu
eNodeB 116
eNodeB 118
Device 112
Device 114
HSS 132
PCRF 134
CSCF 136
IMS AS 138
MRF 140
Media Server 142
BGCF 144
MGCF 146
IMS MG 148
SG 150
IMS 130
Sh
Cx
ISC
SIP/RTP
To VoIP
Mb
Mg
Mj
Mi
GCP
SIGTRAN
To CS Domain
Rx/Gx
S6-a
S7
Rx/GX
S3
Gi
Gn
GGSN 176
SGSN 172
MSC 174
RNC 170
IuPS
IuCS
IuB
HSPA
Uu
NodeB 166
NodeB 168
Device 162
Device 164
3G / 3.5 G 160
Femto Gateway 188
Security Gateway 186
Iu-h
FAP 184
Femtocell 180
Device 180

FIG. 1



UE 210
P-CSCF 212
I-CSCF 214
HSS 216
S-CSCF 218
Register 230
Register 232
Selection Info 234
Register 236
Cx-Put 240
AV-Req 242
AV-Req-Resp 244
Auth. Challenge 250
Auth. Challenge 252
Auth. Challenge 254
Register 260
Register 262
Cx-Query 264
Register 266
Cx-Put 270
Cx-Pull 272
Auth. OK 280
Auth. OK 282
Auth. OK 284

FIG. 2

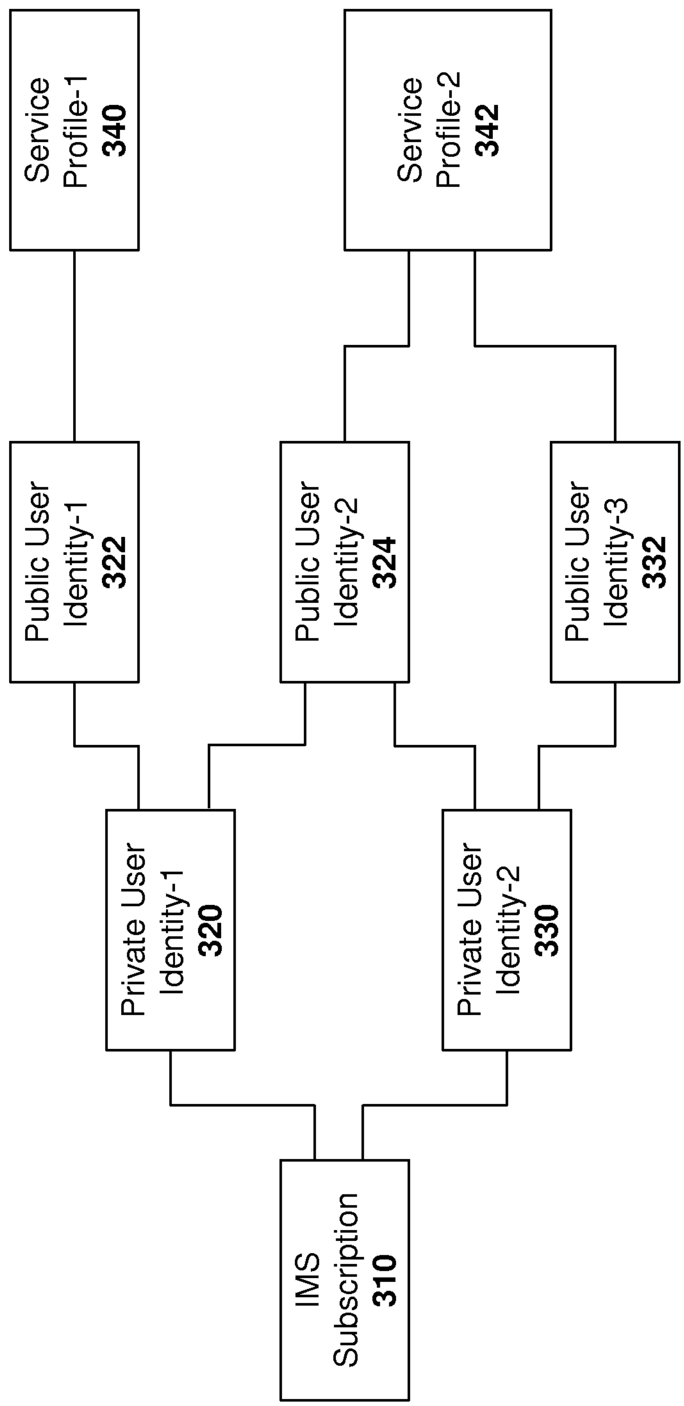

Service Profile-1 340
Service Profile-2 342
Public User Identity-1 322
Public User Identity-2 324
Public User Identity-3 332
Private User Identity-1 320
Private User Identity-2 330
IMS Subscription 310

FIG. 3

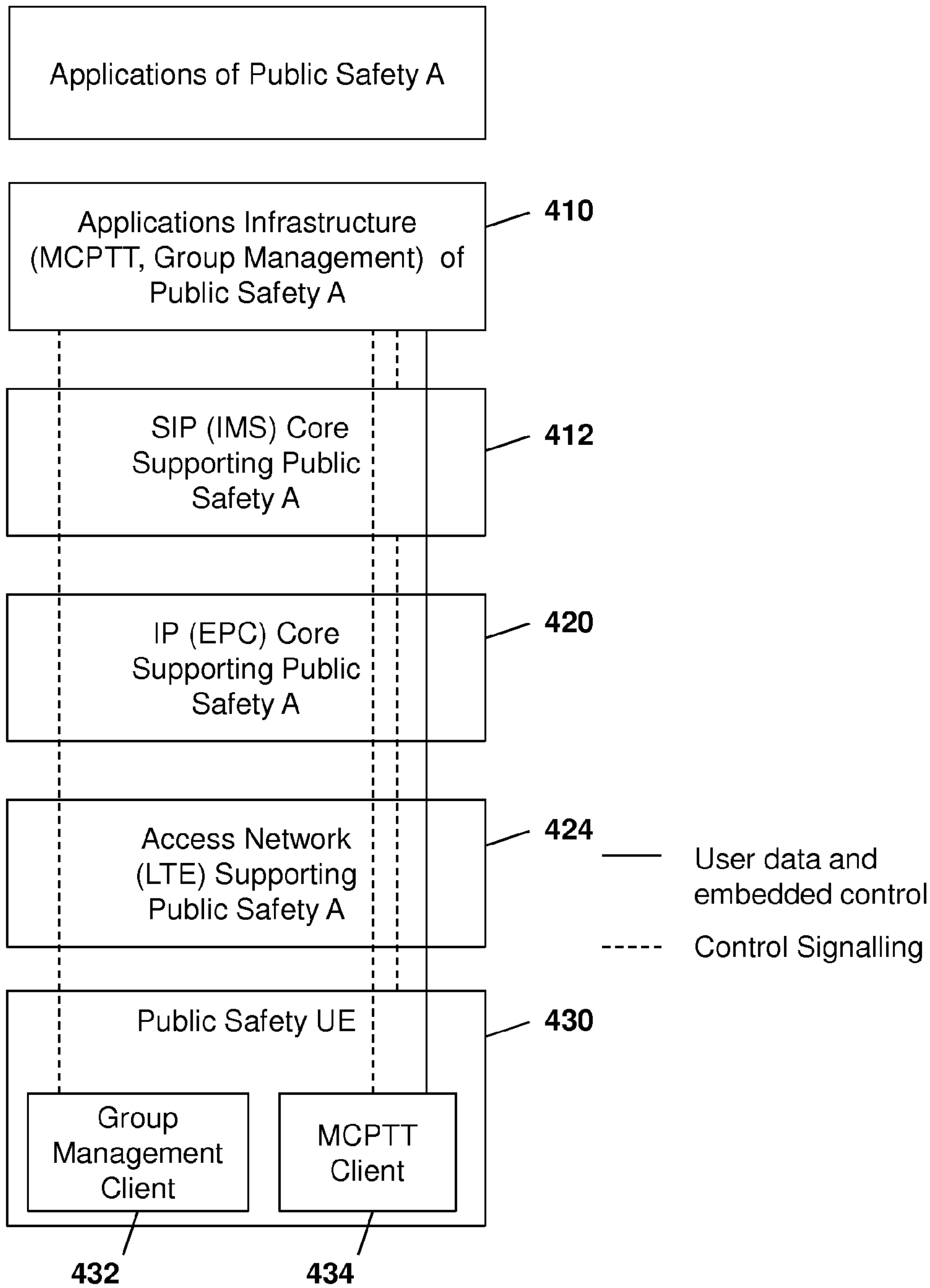

Applications of Public Safety A
Applications Infrastructure (MCPTT, Group Management) of Public Safety A
410
SIP (IMS) Core Supporting Public Safety A
412
IP (EPC) Core Supporting Public Safety A
420
Access Network (LTE) Supporting Public Safety A
424
User data and embedded control
Control Signalling
Public Safety UE
430
Group Management Client
MCPTT Client
432
434

FIG. 4

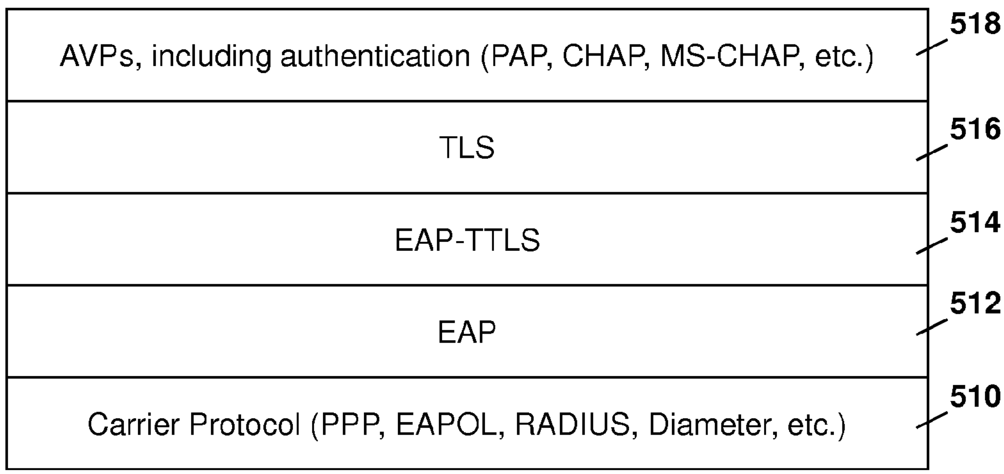

AVPs, including authentication (PAP, CHAP, MS-CHAP, etc.)
518
TLS
516
EAP-TTLS
514
EAP
512
Carrier Protocol (PPP, EAPOL, RADIUS, Diameter, etc.)
510

FIG. 5A

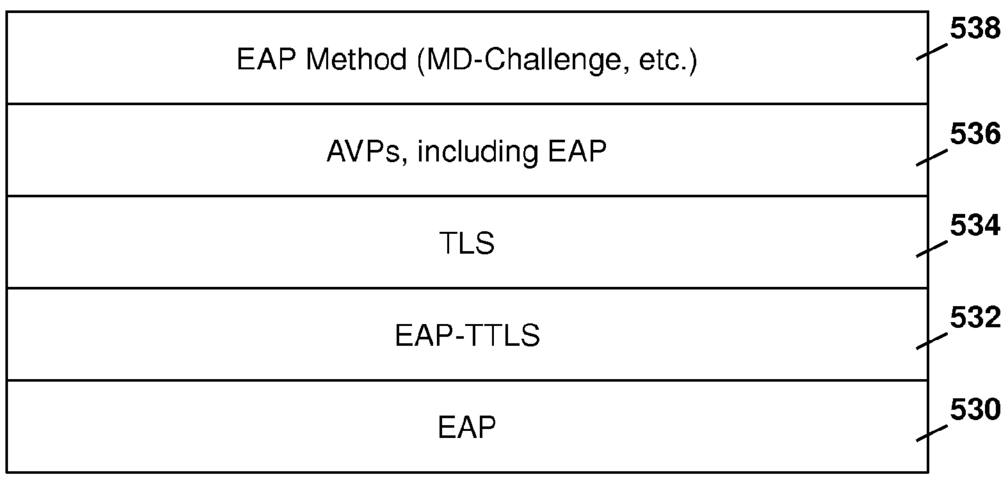

EAP Method (MD-Challenge, etc.)
538
AVPs, including EAP
536
TLS
534
EAP-TTLS
532
EAP
530

FIG. 5B

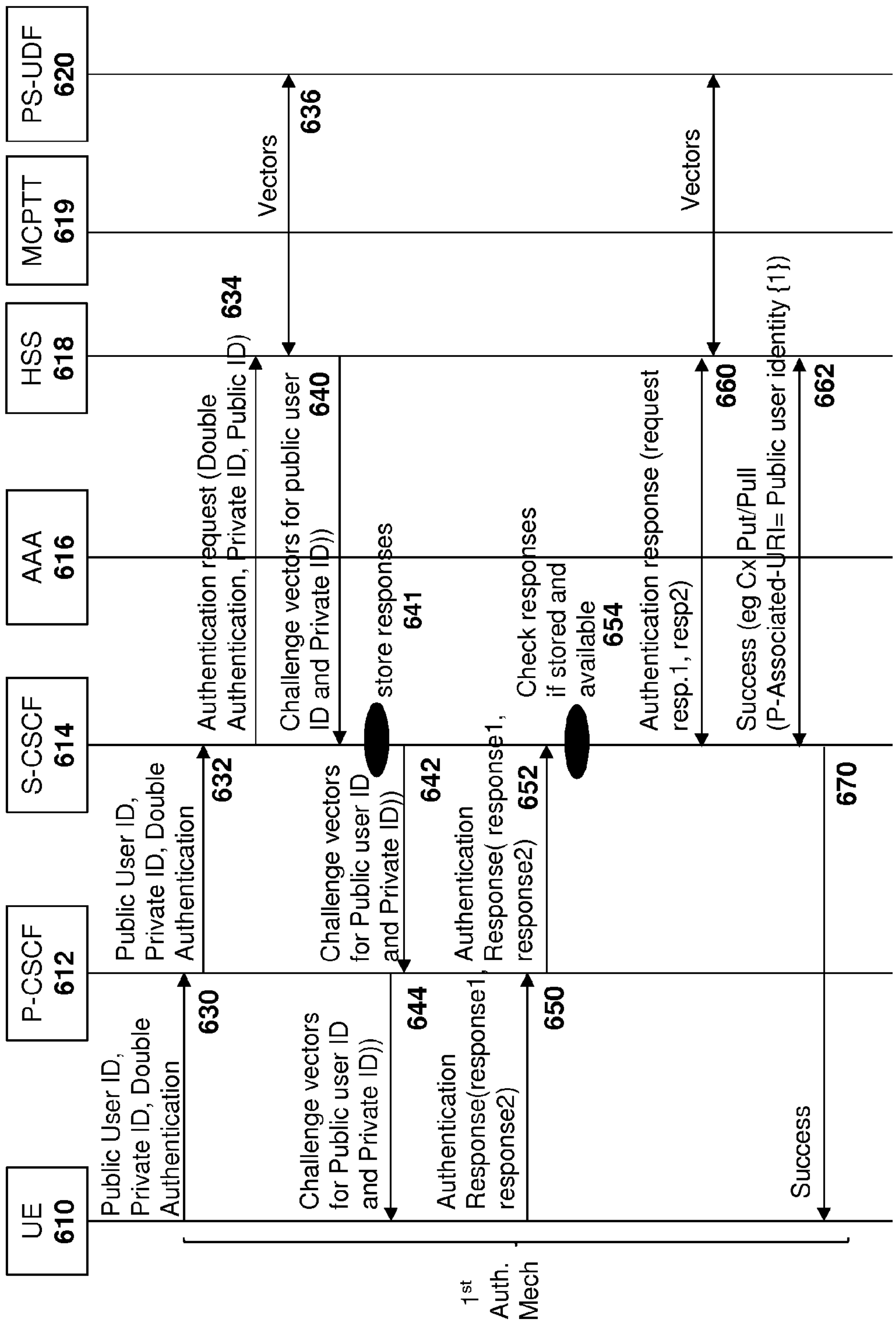

UE 610
P-CSCF 612
S-CSCF 614
AAA 616
HSS 618
MCPTT 619
PS-UDF 620
Public User ID, Private ID, Double Authentication
630
Public User ID, Private ID, Double Authentication
632
Authentication request (Double Authentication, Private ID, Public ID)
634
Vectors
636
Challenge vectors for public user ID and Private ID))
640
store responses
641
Challenge vectors for Public user ID and Private ID))
642
Challenge vectors for Public user ID and Private ID))
644
Authentication Response(response1, response2)
650
Authentication Response(response1, response2)
652
Check responses if stored and available
654
Authentication response (request resp.1, resp2)
660
Vectors
Success (eg Cx Put/Pull (P-Associated-URI= Public user identity {1})
662
Success
670
1st Auth. Mech

FIG. 6

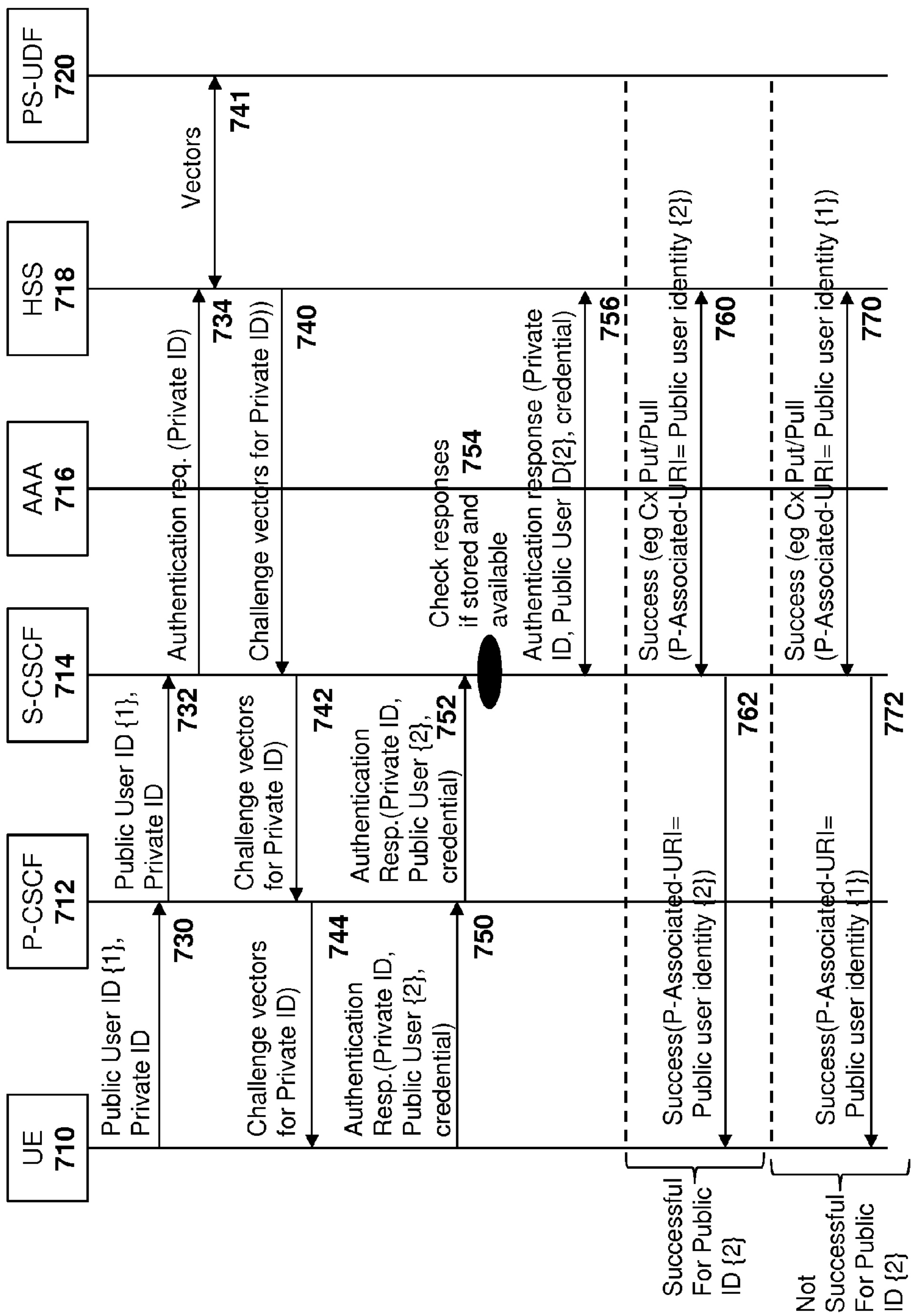

UE 710
P-CSCF 712
S-CSCF 714
AAA 716
HSS 718
PS-UDF 720
Public User ID {1}, Private ID
730
Public User ID {1}, Private ID
732
Authentication req. (Private ID)
734
Vectors
741
Challenge vectors for Private ID))
740
Challenge vectors for Private ID)
742
Challenge vectors for Private ID)
744
Authentication Resp.(Private ID, Public User {2}, credential)
750
Authentication Resp.(Private ID, Public User {2}, credential)
752
Check responses if stored and available
754
Authentication response (Private ID, Public User ID{2}, credential)
756
Success (eg Cx Put/Pull (P-Associated-URI= Public user identity {2})
760
Success(P-Associated-URI= Public user identity {2})
762
Success (eg Cx Put/Pull (P-Associated-URI= Public user identity {1})
770
Success(P-Associated-URI= Public user identity {1})
772
Successful For Public ID {2}
Not Successful For Public ID {2}

FIG. 7

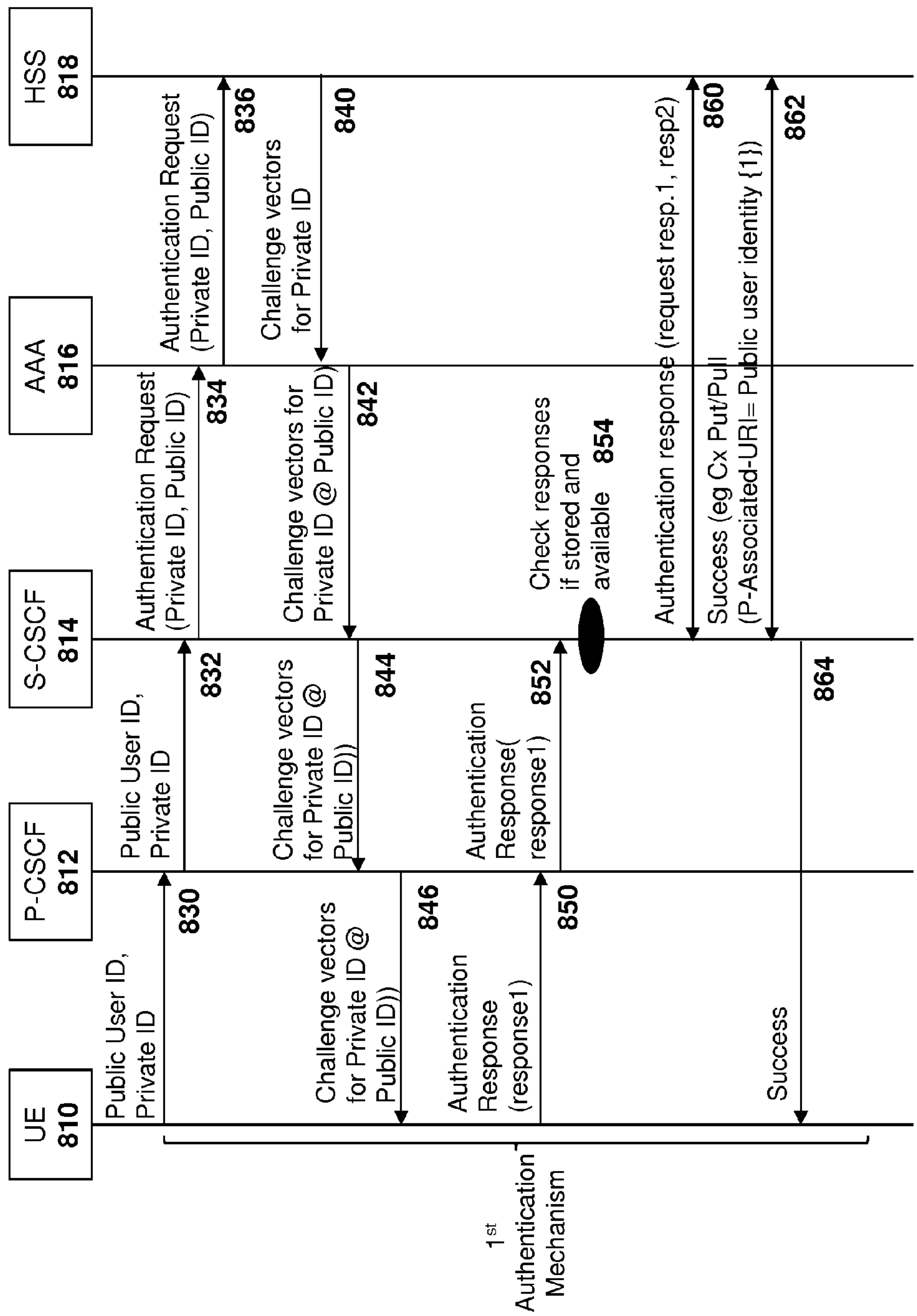
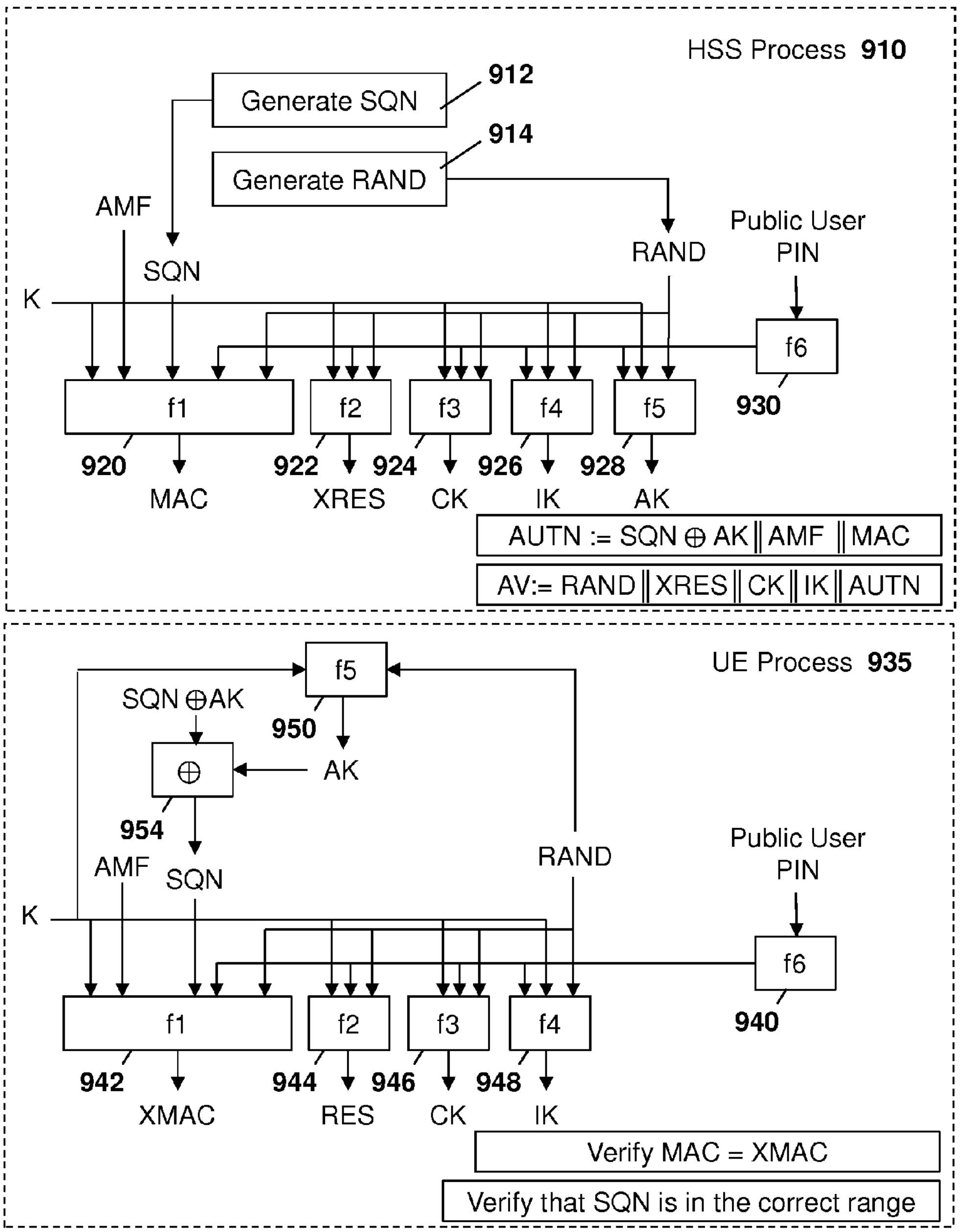

UE
810
P-CSCF
812
S-CSCF
814
AAA
816
HSS
818
Public User ID,
Private ID
830
Public User ID,
Private ID
832
Authentication Request
(Private ID, Public ID)
834
Authentication Request
(Private ID, Public ID)
836
Challenge vectors
for Private ID
840
Challenge vectors for
Private ID @ Public ID)
842
Challenge vectors
for Private ID @
Public ID))
844
Challenge vectors
for Private ID @
Public ID))
846
Authentication
Response
(response1)
850
Authentication
Response(
response1)
852
Check responses
if stored and
available
854
Authentication response (request resp.1, resp2)
860
Success (eg Cx Put/Pull
(P-Associated-URI= Public user identity {1})
862
Success
864
1st
Authentication
Mechanism

FIG. 8



HSS Process 910
Generate SQN
912
Generate RAND
914
AMF
SQN
RAND
Public User PIN
K
f6
f1
f2
f3
f4
f5
930
920
922
924
926
928
MAC
XRES
CK
IK
AK
AUTN := SQN ⊕ AK ‖ AMF ‖ MAC
AV:= RAND ‖ XRES ‖ CK ‖ IK ‖ AUTN
UE Process 935
f5
SQN ⊕AK
950
⊕
AK
954
AMF
SQN
RAND
Public User PIN
K
f6
f1
f2
f3
f4
940
942
944
946
948
XMAC
RES
CK
IK
Verify MAC = XMAC
Verify that SQN is in the correct range

FIG. 9

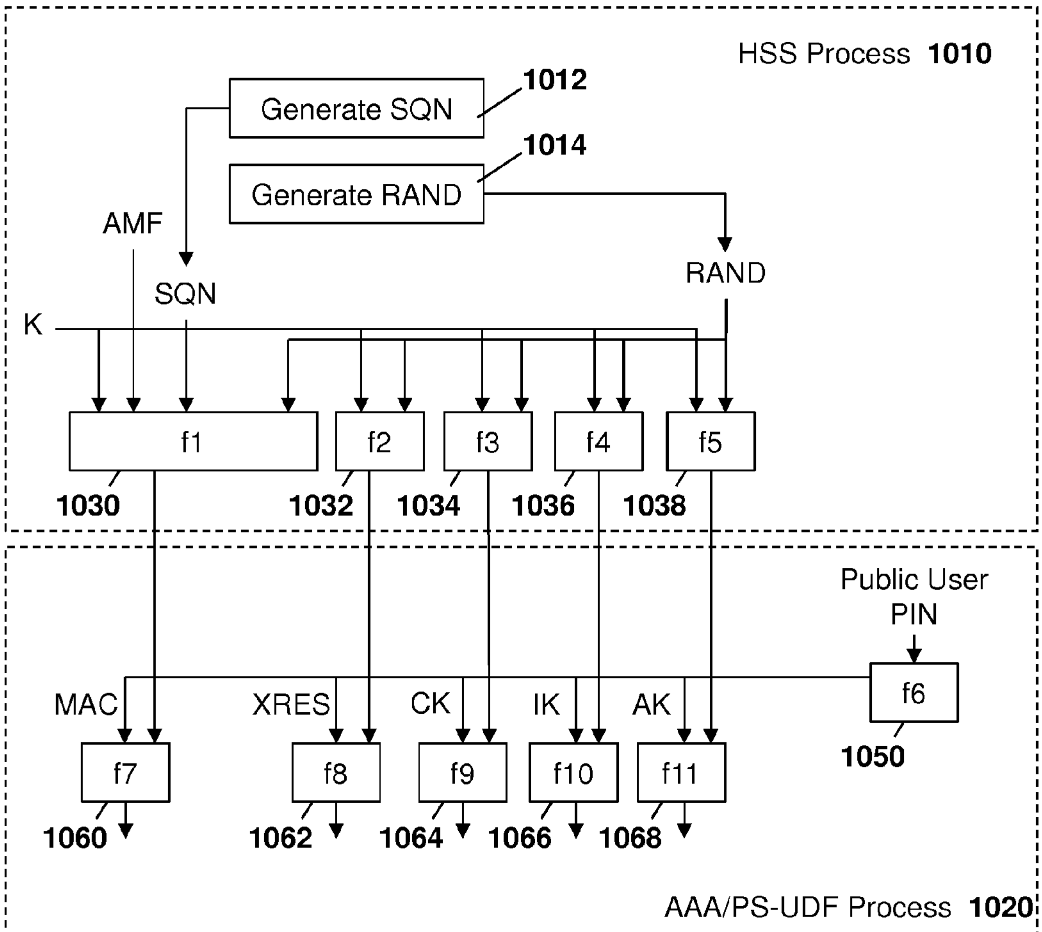

HSS Process 1010
Generate SQN
1012
Generate RAND
1014
AMF
SQN
RAND
K
f1
f2
f3
f4
f5
1030
1032
1034
1036
1038
Public User
PIN
f6
1050
MAC
XRES
CK
IK
AK
f7
f8
f9
f10
f11
1060
1062
1064
1066
1068
AAA/PS-UDF Process 1020

FIG. 10

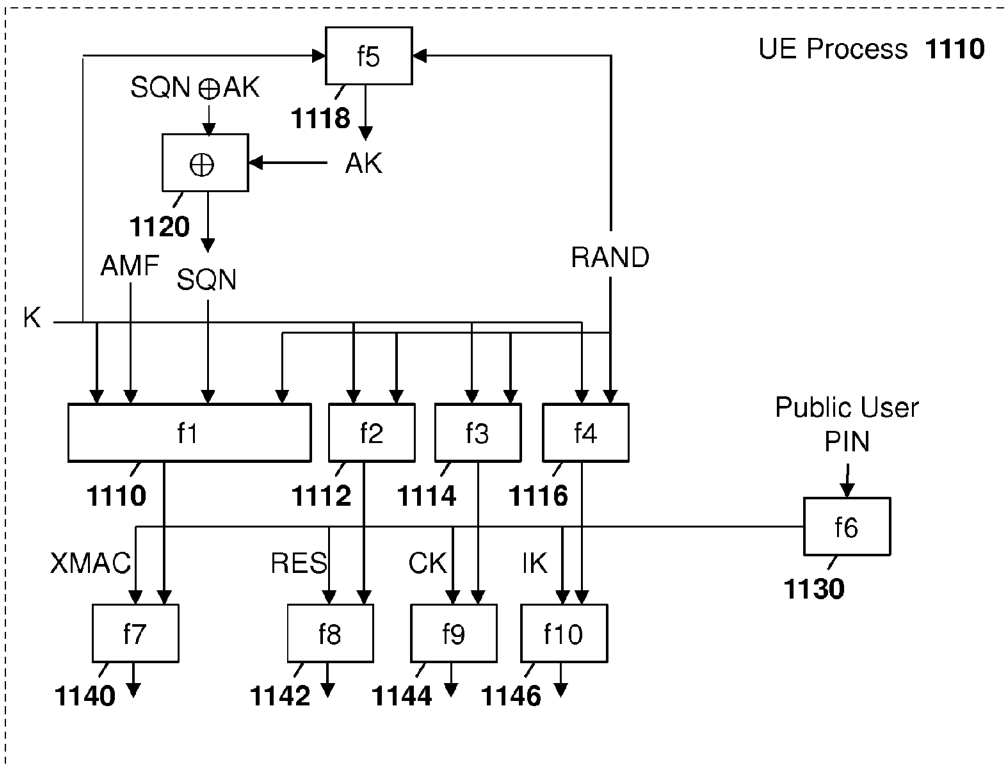
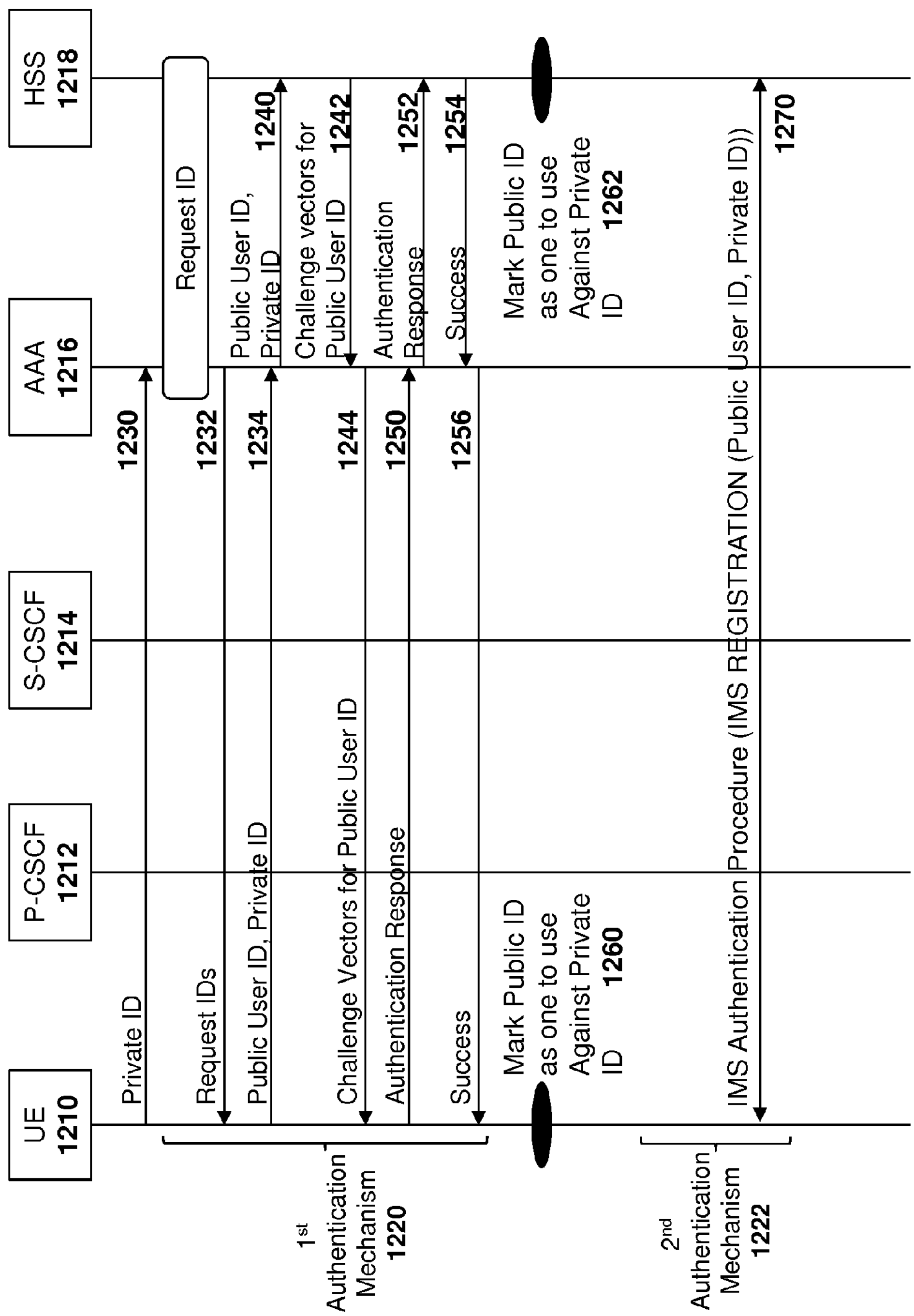
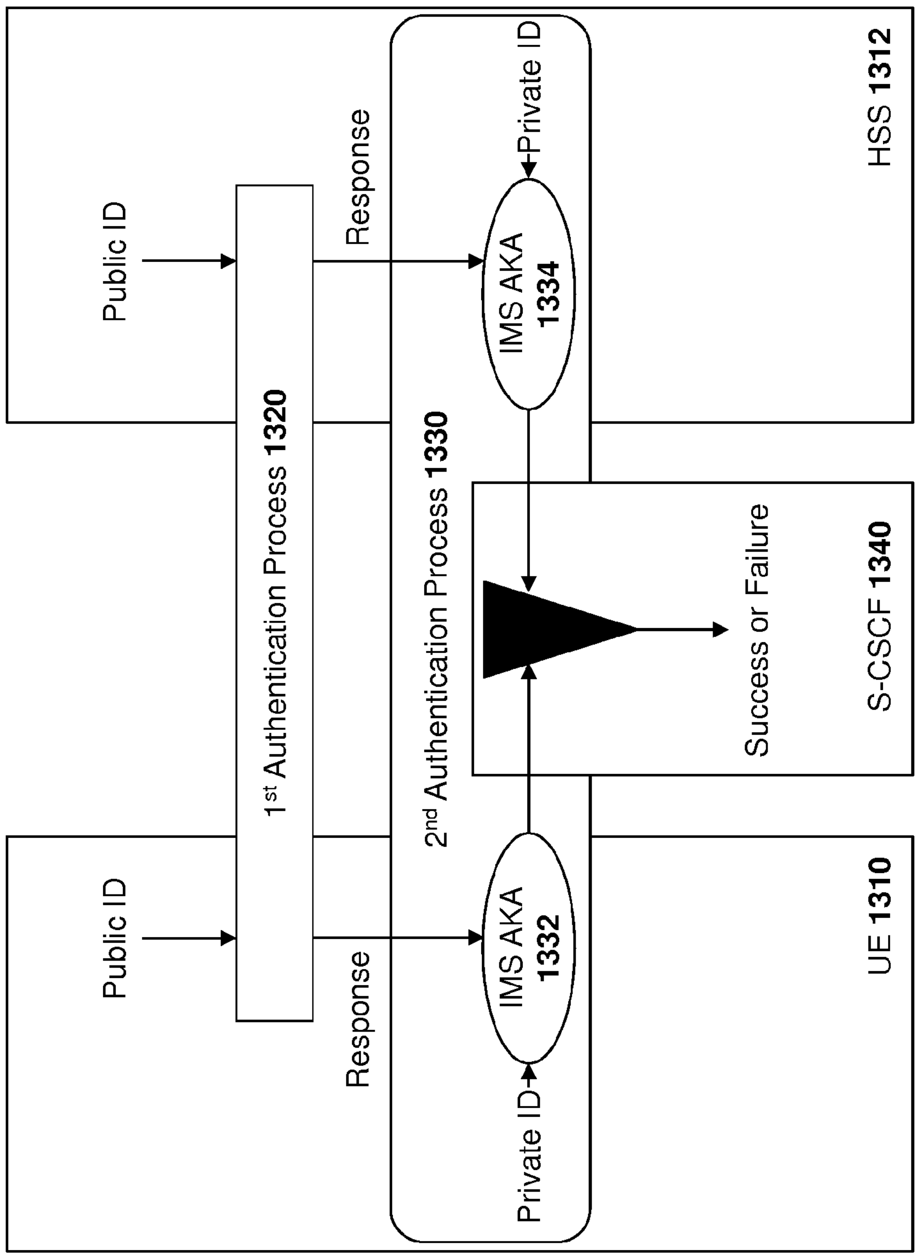

UE Process 1110
f5
1118
SQN ⊕AK
⊕
AK
1120
AMF
SQN
RAND
K
f1
f2
f3
f4
Public User
PIN
1110
1112
1114
1116
f6
XMAC
RES
CK
IK
1130
f7
f8
f9
f10
1140
1142
1144
1146

FIG. 11



UE 1210
P-CSCF 1212
S-CSCF 1214
AAA 1216
HSS 1218
Private ID
1230
Request IDs
1232
Request ID
Public User ID, Private ID
1234
Public User ID, Private ID
1240
Challenge vectors for Public User ID
1242
Challenge Vectors for Public User ID
1244
Authentication Response
1250
Authentication Response
1252
Success
1254
Success
1256
Mark Public ID as one to use Against Private ID 1260
Mark Public ID as one to use Against Private ID 1262
IMS Authentication Procedure (IMS REGISTRATION (Public User ID, Private ID))
1270
1st Authentication Mechanism 1220
2nd Authentication Mechanism 1222

FIG. 12



UE 1310
S-CSCF 1340
HSS 1312
Public ID
Public ID
1st Authentication Process 1320
Response
Response
2nd Authentication Process 1330
IMS AKA 1332
IMS AKA 1334
Private ID
Private ID
Success or Failure

FIG. 13

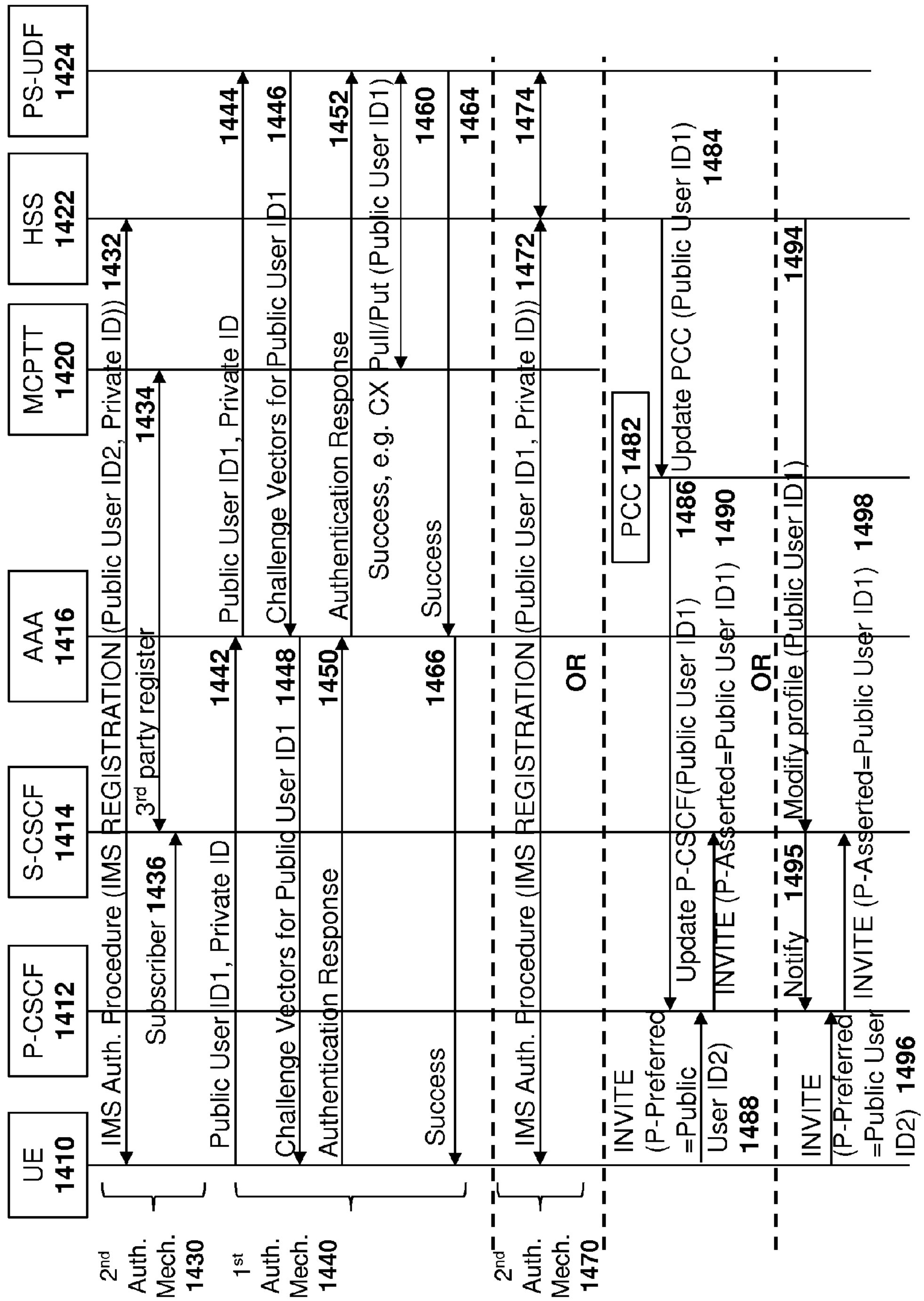
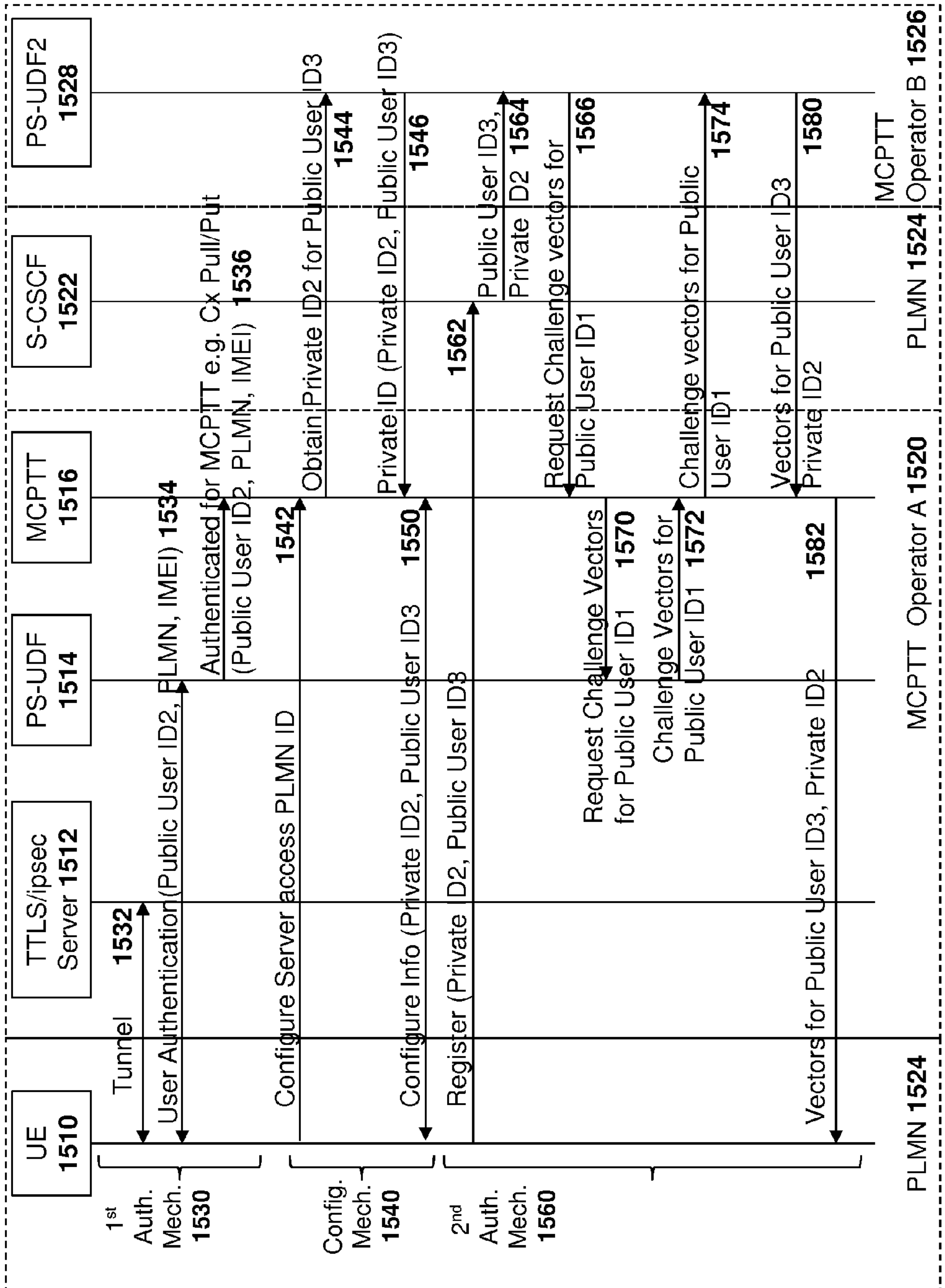

UE 1410
P-CSCF 1412
S-CSCF 1414
AAA 1416
MCPTT 1420
HSS 1422
PS-UDF 1424
2nd Auth. Mech. 1430
IMS Auth. Procedure (IMS REGISTRATION (Public User ID2, Private ID)) 1432
3rd party register 1434
Subscriber 1436
1st Auth. Mech. 1440
Public User ID1, Private ID 1442
Public User ID1, Private ID 1444
Challenge Vectors for Public User ID1 1446
Challenge Vectors for Public User ID1 1448
Authentication Response 1450
Authentication Response 1452
Success, e.g. CX Pull/Put (Public User ID1) 1460
Success 1464
Success 1466
2nd Auth. Mech. 1470
IMS Auth. Procedure (IMS REGISTRATION (Public User ID1, Private ID)) 1472
1474
OR
PCC 1482
Update PCC (Public User ID1) 1484
Update P-CSCF(Public User ID1) 1486
INVITE (P-Preferred =Public User ID2) 1488
INVITE (P-Asserted=Public User ID1) 1490
OR
Modify profile (Public User ID1) 1494
Notify 1495
INVITE (P-Preferred =Public User ID2) 1496
INVITE (P-Asserted=Public User ID1) 1498

FIG. 14



UE 1510
TTLS/ipsec Server 1512
PS-UDF 1514
MCPTT 1516
S-CSCF 1522
PS-UDF2 1528
1st Auth. Mech. 1530
Tunnel 1532
User Authentication (Public User ID2, PLMN, IMEI) 1534
Authenticated for MCPTT e.g. Cx Pull/Put (Public User ID2, PLMN, IMEI) 1536
Config. Mech. 1540
Configure Server access PLMN ID 1542
Obtain Private ID2 for Public User ID3 1544
Private ID (Private ID2, Public User ID3) 1546
Configure Info (Private ID2, Public User ID3 1550
2nd Auth. Mech. 1560
Register (Private ID2, Public User ID3 1562
Public User ID3, Private ID2 1564
Request Challenge vectors for Public User ID1 1566
Request Challenge Vectors for Public User ID1 1570
Challenge Vectors for Public User ID1 1572
Challenge vectors for Public User ID1 1574
Vectors for Public User ID3 Private ID2 1580
Vectors for Public User ID3, Private ID2 1582
PLMN 1524
MCPTT Operator A 1520
PLMN 1524
MCPTT Operator B 1526

FIG. 15

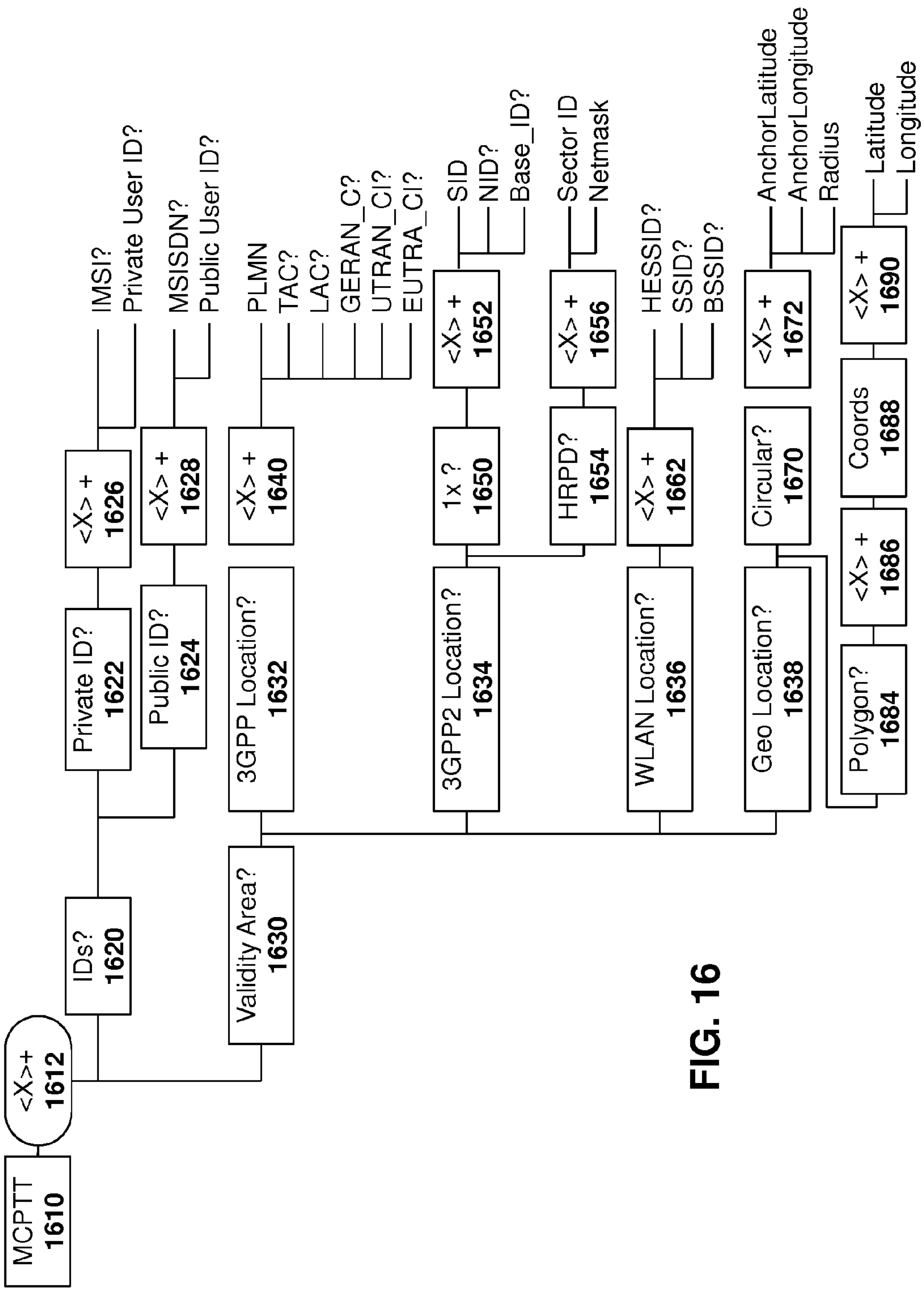

MCPTT
1610
<X>+
1612
IDs?
1620
Private ID?
1622
<X> +
1626
IMSI?
Private User ID?
Public ID?
1624
<X> +
1628
MSISDN?
Public User ID?
Validity Area?
1630
3GPP Location?
1632
<X> +
1640
PLMN
TAC?
LAC?
GERAN_CI?
UTRAN_CI?
EUTRA_CI?
3GPP2 Location?
1634
1x ?
1650
<X> +
1652
SID
NID?
Base_ID?
HRPD?
1654
<X> +
1656
Sector ID
Netmask
WLAN Location?
1636
<X> +
1662
HESSID?
SSID?
BSSID?
Geo Location?
1638
Circular?
1670
<X> +
1672
AnchorLatitude
AnchorLongitude
Radius
Polygon?
1684
<X> +
1686
Coords
1688
<X> +
1690
Latitude
Longitude

FIG. 16

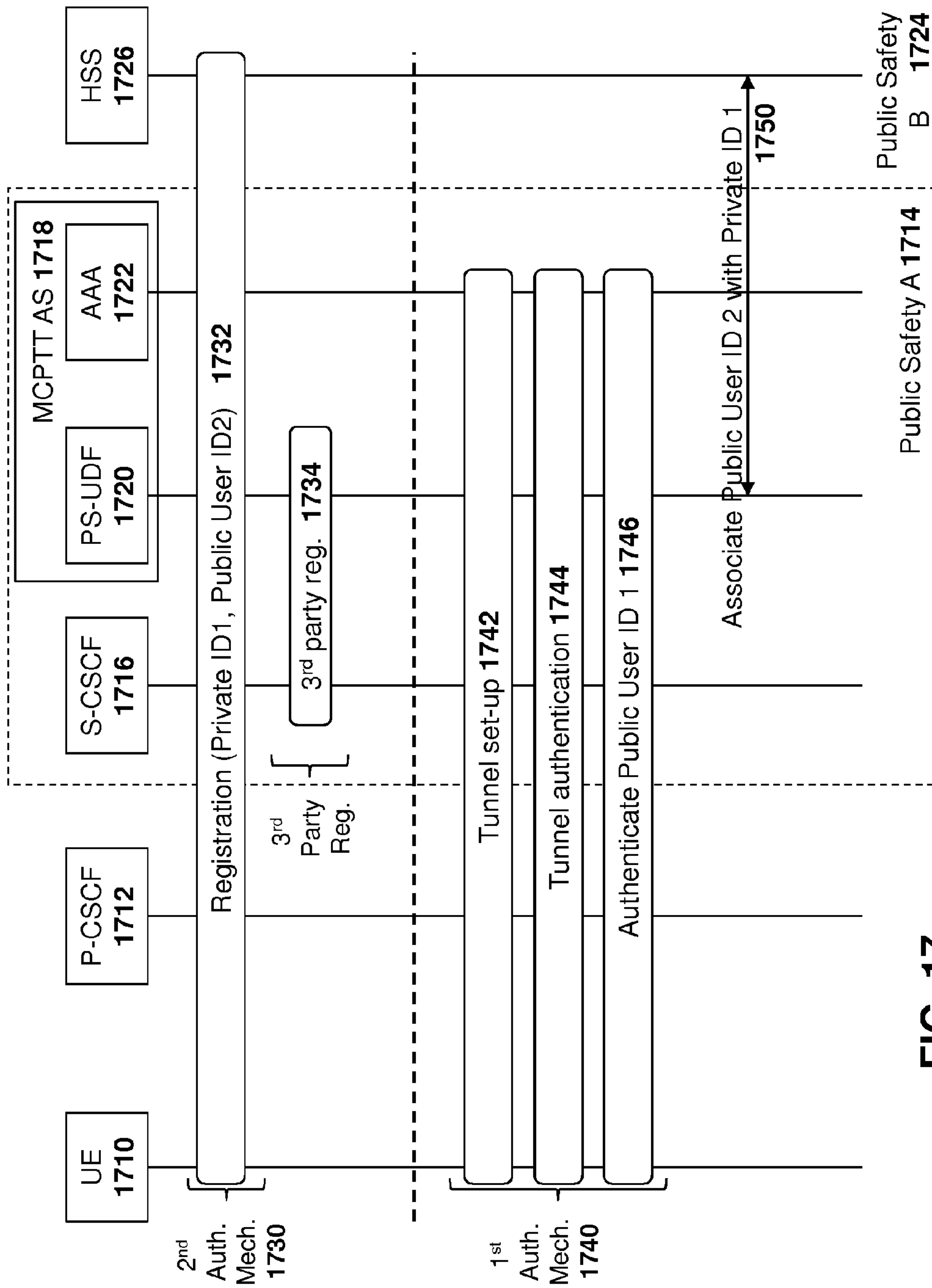

UE 1710
P-CSCF 1712
S-CSCF 1716
PS-UDF 1720
AAA 1722
MCPTT AS 1718
HSS 1726
Registration (Private ID1, Public User ID2) 1732
3rd party reg. 1734
3rd Party Reg.
2nd Auth. Mech. 1730
1st Auth. Mech. 1740
Tunnel set-up 1742
Tunnel authentication 1744
Authenticate Public User ID 1 1746
Associate Public User ID 2 with Private ID 1 1750
Public Safety A 1714
Public Safety B 1724

FIG. 17

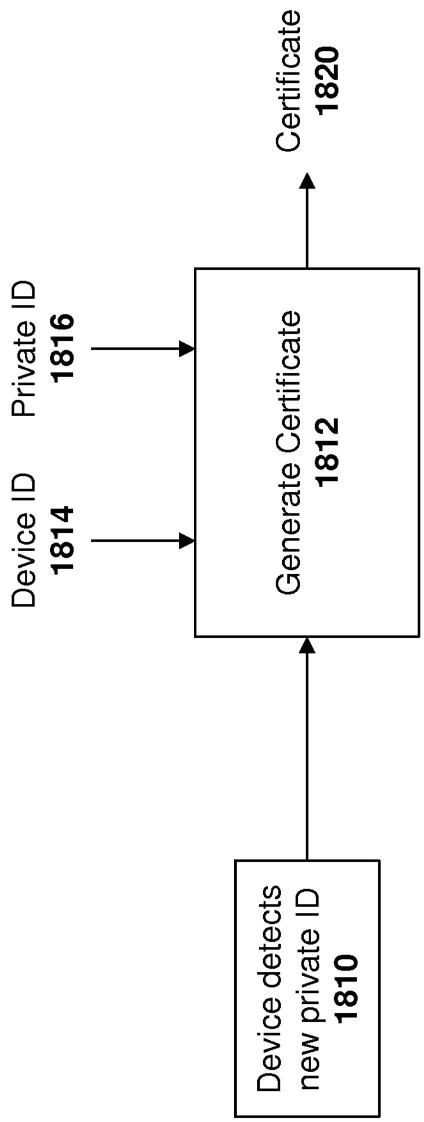

Device detects new private ID
1810
Generate Certificate
1812
Device ID
1814
Private ID
1816
Certificate
1820

FIG. 18

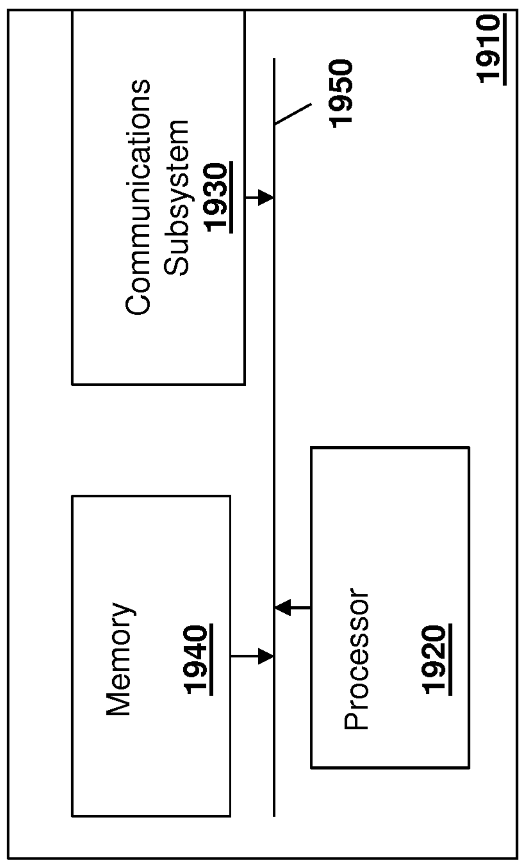

Communications Subsystem
1930
1950
1910
Memory
1940
Processor
1920

FIG. 19

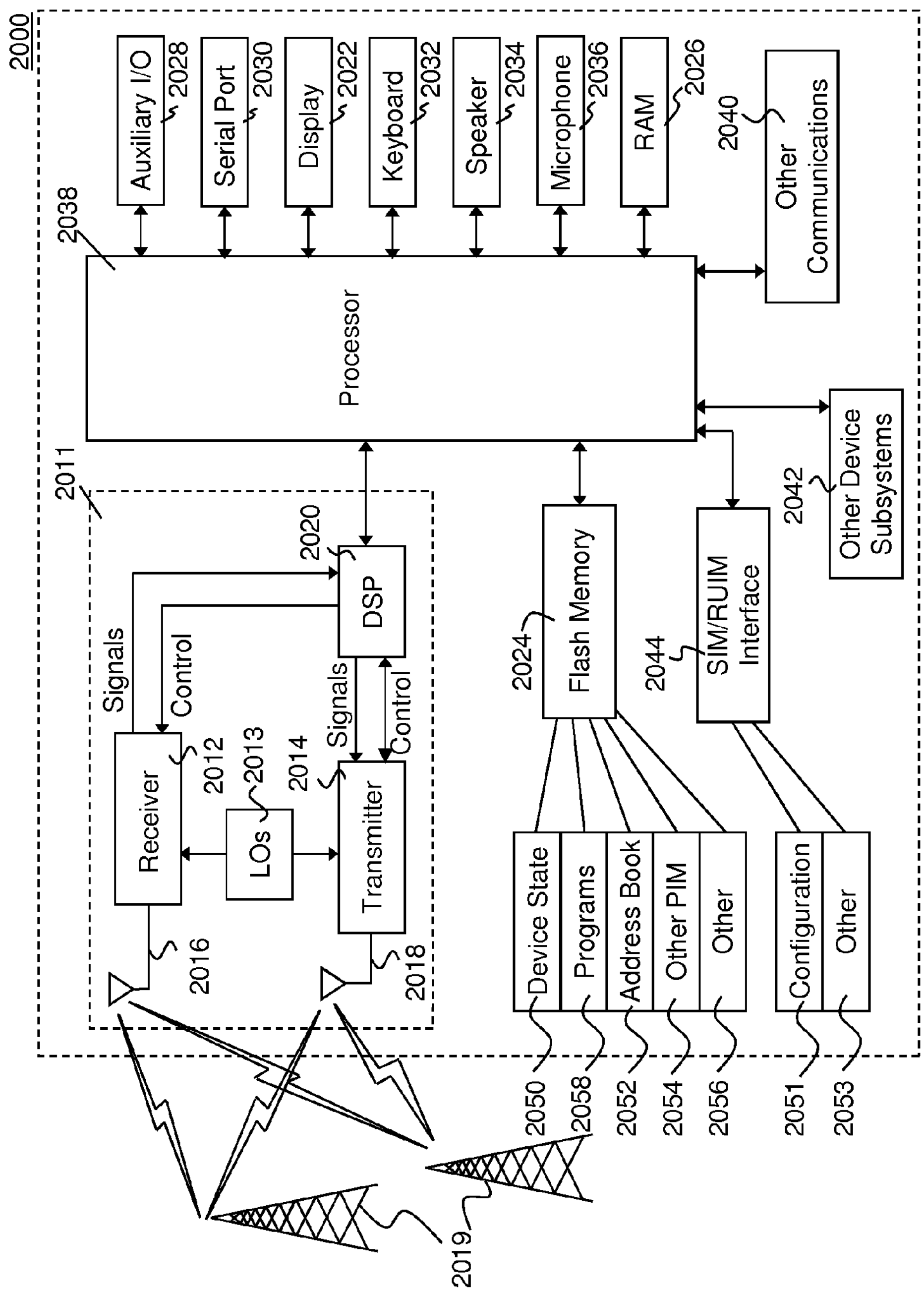

2000
Auxiliary I/O
2028
Serial Port
2030
Display
2022
Keyboard
2032
Speaker
2034
Microphone
2036
RAM
2026
2040
Other Communications
2038
Processor
2011
2020
DSP
Signals
Control
Signals
Control
Receiver
2012
2013
LOs
2014
Transmitter
2016
2018
2024
Flash Memory
2044
SIM/RUIM Interface
2042
Other Device Subsystems
Device State
Programs
Address Book
Other PIM
Other
Configuration
Other
2050
2058
2052
2054
2056
2051
2053
2019

FIG. 20

METHOD AND SYSTEM TO AUTHENTICATE MULTIPLE IMS IDENTITIES

FIELD OF THE DISCLOSURE

The present disclosure relates to an internet protocol (IP) multimedia subsystem (IMS), and in particular relates to the validation of identities in an IMS network.

BACKGROUND

The IP multimedia subsystem is an architectural framework for providing packet data to mobile devices in a standardized fashion. Such IMS network allows for voice calls over a packet system rather the circuit switched system. It allows for other functionalities such as push to talk (PTT), and in particular, mission critical push to talk (MCPTT) used for first responders.

IMS authentication authenticates both a private identifier and a public identifier for use on the IMS network. However, the IMS authentication does not allow different individual IMS public user identities to be separately authenticated with the same or different IMS private user identities. This can lead to problems in various situations. For example, if used by first responders, a MCPTT application may need a device to be authenticated by a different public identity than that tied to the private identity of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will be better understood with reference to the drawings, in which:

FIG. **1** is a block diagram of an example IMS network;

FIG. **2** is a data flow diagram showing authentication of an IM-subscriber;

FIG. **3** is a block diagram showing an association between private and public user identities in an IMS system;

FIG. **4** is a block diagram showing signaling between a public safety operator and a public safety UE, including various network elements;

FIG. **5**A is a block diagram of a protocol stack for EAP authentication;

FIG. **5**B is a block diagram of a protocol stack when the EAP is the user authentication protocol;

FIG. **6** is a data flow diagram showing a first in band embodiment providing an indication for double authentication;

FIG. **7** is a data flow diagram for an alternative in band embodiment in which a second public user identity is used in authentication;

FIG. **8** is a data flow diagram of an in band embodiment showing keying based on public user identifiers;

FIG. **9** is a block diagram showing a process for key generation in an HSS and a UE;

FIG. **10** is a block diagram of a key generation process at a network element in which a public user PIN is obscured from a carrier;

FIG. **11** is a block diagram of a key generation process at a user equipment in which a public user PIN is obscured from a carrier;

FIG. **12** is a data flow diagram showing an out of band embodiment for IMS authentication;

FIG. **13** is a block diagram showing an out of band authentication process;

FIG. **14** is a data flow diagram showing an out of band embodiment utilizing different public user identities for authentication;

FIG. **15** is a data flow diagram shown an out of band embodiment in which a UE can roam into a second MCPTT network;

FIG. **16** is a block diagram showing an example data structure for MCPTT data;

FIG. **17** is a data flow diagram showing authentication utilizing certificates;

FIG. **18** is a block diagram showing the generation of a certificate;

FIG. **19** is a simplified block diagram of an example network element; and

FIG. **20** is a block diagram of an example user equipment for use with the embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

The present disclosure provides a method at a user equipment for registering with a third network node using an internet protocol (IP) multimedia subsystem (IMS), the method comprising: creating a tunnel between the user equipment and a first network node; authenticating a first public identity associated with the user equipment to the first network node; receiving configuration information from the first network node with a second private user identifier and a second public user identifier, the second private user identifier and second public user identifier being associated with a second network node; and registering with a third network node using the second private user identifier and the second public user identifier.

The present disclosure further provides a user equipment configured for registering with a third network node using an internet protocol (IP) multimedia subsystem (IMS), the user equipment comprising: a processor; and a communications subsystem, wherein the user equipment is configured to: create a tunnel between the user equipment and a first network node; authenticate a first public identity associated with the user equipment to the first network node; receive configuration information from the first network node with a second private user identifier and a second public user identifier, the second private user identifier and second public user identifier being associated with a second network node; and register with a third network node using the second private user identifier and the second public user identifier.

The present disclosure further provides a method at first network node configured for authentication between a user equipment and a third network node using an internet protocol (IP) multimedia subsystem (IMS), the method comprising: establishing a tunnel with the user equipment; authenticating a first public identity of the user equipment at first network node; receiving a configuration information message from the user equipment, the configuration information message including a network identifier for a network the user equipment is registered on; obtaining, from a second network node, a second private user identifier and second public user identifier; and providing the second private user identifier and second public user identifier to the user equipment.

The present disclosure further provides a first network node configured for authentication between a user equipment and a third network node using an internet protocol (IP) multimedia subsystem (IMS) the first network node comprising: a processor; and a communications subsystem, wherein the first network node is configured to: establish a tunnel with the user equipment; authenticate a first public identity of the user equipment at first network node; receive a configuration information message from the user equipment, the configuration information message including a network identifier for a network the user equipment is registered on; obtain, from a second network node, a second private user identifier and second public user identifier; and provide the second private user identifier and second public user identifier to the user equipment.

The present disclosure relates generally to authentication in IMS systems. In one aspect of such authentication, the use of the IMS system with regard to MCPTT is discussed below. However, this is not the only use of the IMS network and IMS authentication could equally be used for separate or different applications. The use of MCPTT below is therefore meant to be illustrative only.

One example of a deficiency of IMS authentication is illustrated with regard to MCPTT. MCPTT is utilized, for example, by first responders, and has various requirements. These may include, but are not limited to, that any user should be able to pick up any device and use it. Thus, if a fire station has a number of devices that are not individually assigned, but are provided to users on an as needed basis, any firefighter should be able to pick up any of the devices that are available and utilize such device.

MCPTT may further require that authentication of the MCPTT application on a device needs to be independent of the cellular/IMS network in order to meet security requirements of the public safety service provider and public safety users.

In a third aspect, MCPTT may need to be capable of hiding or obscuring the identity or role of a user who is using the device. For example, in the case where the first responder is a police officer, in some situations it may be desirable to protect the confidentiality of the identity of that police officer when using the MCPTT application. The obscuring may need to include obscuring a true public identity from a carrier or network operator.

Given the three aspects described above, and the way that IMS authentication works as described below, IMS authentication does not provide for compatible functionality with MCPTT. Specifically, the current IMS method of authentication is based on an IMS private user identity, and does not allow for different individual IMS public user identities to be separately authenticated with the same or different IMS private user identity. Thus, for example, if a first user and a second user use the same mobile device in a non-concurrent way, then the system is unable to differentiate who the user is and hence unable to authenticate the two users differently and is incapable of denying one access while granting the other access. Thus the present disclosure provides for a method and system for authenticating both the device and the user and then providing for a determination if a user should be allowed to use the device or not.

As used herein, the terms private identifier and private user identifier may be used interchangeably.

In accordance with the disclosure below, various solutions to the above problem are provided. In particular, the present disclosure describes various in band solutions, which utilize current IMS authentication messaging to piggy back a separate public identity verification. Other solutions described below include out of band solutions which provide for the verification of a public identity utilizing messaging outside of regular IMS authentication. Further, various keying based on a public user identity are provided which may be used in either the in band or out of band signaling solutions described below. One skilled in the art will appreciate that these in band, out of band and keying based on public user identity can be combined in numerous ways to result in additional embodiments.

In one aspect of the embodiments described below, the user identity of a particular user may be obscured in a system, and various solutions are provided for the obscuring of a public identity.

Reference is now made to FIG. 1, which shows an overview of an example IMS network attached to a 4^{th} Generation (4G) network. The example of FIG. 1 is merely meant to illustrate various components within a network architecture. The embodiment of FIG. 1 is not limiting and real networks will have some or all of the components, along with additional components, in most cases.

Further, as described below, each of the elements may be considered to be a logical block. That is, the functionality of elements may be combined onto one server. Further, the functionality of a single element may be split over multiple physical servers and the present disclosure is not limited to the use of any particular physical architecture.

In the example of FIG. 1, a 4^{th} Generation (4G) network **110** may utilize an IMS network **130** to provide for standardized packet data communications. In particular, 4G network **110** may be a third generation (3G) long term evolution (LTE) or system architecture evolution (SAE) network in which a device **112** or a device **114** may communicate. Devices **112** and **114** may be any device that is capable of communicating over a cellular network, and may include, for example, a user equipment (UE), a mobile device, a smartphone, a laptop, a tablet, or any other data capable device.

Device **112** communicates through an evolved Node-B (eNB) **116** utilizing orthogonal frequency division multiplexing (OFDM), communication over an LTE-Uu interface.

Similarly, device **114** communications with eNB **118** over an LTE-Uu interface.

Each of eNBs **116** and **118** communicate with two entities, namely serving gateway **120** and mobility management entity (MME) **122**. MME **122** is responsible for idle mode UEs paging and is also responsible for choosing a serving gateway **120** when a UE moves into a connected mode.

Serving gateway **120** routes and forwards packets from devices **112** and **114**.

The serving gateway **120** communicates with SAE anchor **124**. SAE anchor **124** is a functional entity that anchors the user plane for mobility between the 3^{rd} Generation Partnership Project (3GPP) access stratum and non-3GPP access stratum for systems such as the Institute for Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), among other non-3GPP access systems.

MME **122** communicates with a 3GPP anchor **126**. 3GPP anchor **126** is a functional entity that anchors the user plane for mobility between second generation and third generation access stratum and the LTE access system.

IMS network **130** may communicate with 4G network **110** through various logical entities. In a first aspect, MME **122** may communicate with a home subscriber server (HSS) **132**. HSS **132** is a database that contains the subscriber's profile including identities and what services they have subscribed to, and that provides location functionality as well as an authentication database.

MME **122** may also communicate with the policy and charging rules function (PCRF) server **134**. The PCRF **134** is an element within the IMS network that controls both the policies of subscribers as well as the amounts charged to such subscribers.

The PCRF **134** and the HSS **132**, as well as 3GPP anchor **126**, may communicate with the call server control function (CSCF) **136** of IMS network **130**. CSCF **136** provides several session initiation protocol (SIP) servers or proxies that are used to process SIP signaling packets in the IMS network **130**.

In particular, CSCF **136** may include various logical entities including a proxy call session control function (P-CSCF), which is the first point of entry into the IMS network. Further, a serving call session control function (S-CSCF) handles sessions in the network and routes SIP messages to appropriate P-CSCFs as well as IMS application servers (IMS AS). Further, CSCF **136** may include an interrogating call session control function (I-CSCF) that is used as an entry point to find a subscriber in the network and assist in assigning an S-CSCF when a subscriber registers in the network.

IMS application server (AS) **138** is an application server that has the logic and software which executes services for an IMS subscriber. IMS network **130** may have between **0** and many of these IMS AS **138** in the network. CSCF **136** may provide output to voice-over IP services (VOIP), as shown in the example of FIG. **1**.

CSCF **136** may further communicate with a media resource function (MRF) **140**, which provides media related functions such as media manipulation. MRF **140** may further be connected to a media server **142**.

CSCF **136** may be connected with a breakout gateway control function (BGCF) **144**, which allows for the processing of SIP requests from an S-CSCF when domain name server (DNS) routing cannot be used.

Both CSCF **136** and BGCF **144** may communicate with a media gateway control function (MGCF) **146**, which is in communication with an IMS media gateway (IMS MG) **148** to allow access to a circuit switched domain.

Further, MGCF **146** may communicate with a signaling gateway (SG) **150**, which may also allow for communications with a circuit switched domain.

In certain circumstances, besides a 4G network **110**, a 3G network or 3.5G network **160** may be utilized. In this case, devices **162** or **164** may communicate with node-B **166** and node-B **168** respectively, utilizing high speed packet access (HSPA) over a Uu interface.

Both node-Bs **166** and **168** communicate with a radio network control (RNC) **170**, which controls the node-Bs that are connected to RNC **170**.

RNC **170** communicates with a serving general packet radio service (GPRS) support node (SGSN) **172**, which is responsible for delivering packets to and from mobile stations that are in the geographical location of the SGSN **172**. RNC **170** further communicates with mobile switching center (MSC) **174** which controls network switching elements.

SGSN **172** may be connected to a gateway GPRS support node (GGSN) **176**. SGSN **172** further communicates with MME **122** and with serving gateway **120** in a 4G network for transferring devices between the 4G and the 3G networks.

GGSN **176** may further utilize the IMS network **130** through CSCF **136**.

In the embodiment of FIG. **1**, a femtocell **180** is further provided. In this example, a device **182** communicates with a femtocell access point **184** over a high speed packet access link.

Femtocell **180** may include a security gateway **186** as well as a femtogateway **188**. Femtogateway **188** may then communicate with SGSN **172** and MSC **174** in 3G network **160**.

As indicated above, FIG. **1** is meant to merely show elements of the communications utilizing an IMS network **130** and other examples and network architectures are therefore possible.

IMS Authentication

As indicated above, a device such as device **112**, **114**, **162**, **164** or **180** from FIG. **1** above, may wish to authenticate with the IMS network **130**. Currently, authentication includes first registering with the network. The IMS registration is independent of the underlying access network, allowing for access agnostic services to be standardized.

When the user registers with the network, a security association is created between the network and the IMS device. This allows the user to use an IMS service that they have subscribed to, and to also protect data by setting up an internet protocol security (IPSec) tunnel between the device and the P-CSCF.

As described below, an IMS device will be referred to as a SIP User Agent (UA). However, this is not limiting and any device could be utilized.

A SIP UA is a logical entity that implements the client SIP functionality. Some implementations of the SIP UA can be wireless or fixed, such as but not limited to set-top boxes, laptops, desktops etc. The SIP UA provides two identities to the network. A first is a private IMS identity, known as the IMS private identity (IMPI) and the other is known as the public user identity, referred to as the IMS public identity (IMPU).

The public identity is the identity that may be used to contact the user. The IMPI is the identity which is used to authenticate the SIP UA and grant access to the IMS system. The IMPI is stored in the HSS **132** in the home operator's network, and may be derived from the international subscriber identity (IMSI) stored on the universal subscriber identity module (USIM) or may be stored in the IMS subscriber identity module (ISIM).

The above is described, for example, in the Third Generation Partnership Project (3GPP) Technical Specification (TS) 33.203, "3G security; Access security for IP-based services", v.12.8.0, December 2012, the contents of which are incorporated herein by reference.

Section 6.1 of this technical standard deals with the authentication and key agreement (AKA). In particular, as described in Section 6.1.0, the IMS AKA achieves mutual authentication between the ISIM if present, else the USIM, and the home network (HN). The identity used for authenticating a subscriber is the private identity, IMPI, which has the form of a network access identifier (NAI), as described, for example in 3GPP TS 23.228 which is in a format as described in RFC 4282. The HSS and the ISIM/USIM share a long-term key associated with the IMPI.

Further, as described in Section 6.1.1 of the 3GPP TS 33.203 specification, before a user can get access to the IM services at least one IMPU needs to be registered and the IMPI authenticated in the IMS at an application level. The IMPI is also therefore used to identify the HSS where the subscription profile is stored.

Both the IMPI and the IMPU can be changed on the USIM/ISIM using Over The Air (OTA) functionality. This OTA functionality allows an operator to change data items on ISIM/USIM.

If the hardware associated with the SIP UA functionality is used to access a 3GPP system, there will also be a universal integrated circuit card (UICC). The UICC contains applications such as a USIM application and possibly an

ISIM application. The USIM and ISIM applications contain identities and authentication algorithms to access the 3GPP network.

The USIM contains the IMSI and the authentication mechanism, which is called 3GPP AKA. The ISIM contains the private identity in the form of a username@domain and the public user identity is also in same form. The ISIM also contains an authentication mechanism called IMS AKA, but the output of the algorithm is different.

Authentication of a SIP UA is therefore performed using the IMPI. The IMPI used for authentication can be likened to that of the IMSI and can be either obtained from the ISIM Private Identity; or derived from the USIM IMSI if the ISIM is not present or does not have an IMPI stored on it.

The IMPI along with an IMPU, is sent in a SIP REGISTRATION message to the network. The network, based on the IMPI used in conjunction with the AKA mechanism, will send back a number of authentication vectors. These are, for example, described in 3GPP TS 33.203 in Section 6.1.1.

Reference is now made to FIG. **2**. In particular, as seen in FIG. **2**, the UE **210** sends a SIP registration message **230** to the P-CSCF **212**. The SIP registration message is then forwarded to the I-CSCF **214** as message **232**. I-CSCF **214** then chooses the HSS **216** and the S-CSCF **218** for the registration message, as shown by block **234** and message **236**.

A challenge is then sent back to the UE and the registration occurs based on the challenge. In particular, the S-CSCF performs a PUT with HSS **216**, as shown by block **240**, and then sends an AV-request to HSS **216**, shown by message **242**. An AV-request-response **244** is received from HSS **216** at S-CSCF **218**.

S-CSCF **218** then sends the authentication challenge to I-CSCF **214** in message **250**. The authentication challenge is forwarded to P-CSCF **212** in message **252** and then to UE **210** in message **254**.

The response to the challenge is in the form of a vector with regard to the IMSI and the response is then sent back to the HSS and S-CSCF which may then confirm whether or not the authentication is okay. Specifically, the response is register message **260**, which is sent from UE **210** to P-CSCF **212**. The response is then forwarded in message **262** to I-CSCF **214**. I-CSCF **214** performs a Cx-Query, shown by block **264**, with HSS **216**, and then forwards the response to S-CSCF **218** as shown by message **266**.

S-SCSF **218** then verifies the response with HSS **216**, shown with Cx-Put block **270** and Cx-Pull block **272**. If the authentication is successful, a success message **280** is sent from S-CSCF **218** to I-CSCF **214**. The success message is then forwarded as message **282** to P-CSCF **212**, and as message **284** to UE **210**.

The IMS also allows more than one public user identity to be associated with the private user identity. In fact the public user identity can be associated with many private user identities as shown, for example, with regard to FIG. **3**.

FIG. **3** is a reproduction of FIG. 4.6 of 3GPP TS 23.228, "IP Multimedia Subsystem (IMS); Stage 2", v.13.2.0, March 2015, the contents of which are incorporated here by reference. In particular, as seen as in FIG. **3**, an IMS subscription **310** includes two private user identities **320** and **330**. Private user identity **320** includes two public user identities, namely public user identity **322** and **324**.

Private user identity **330** further includes public user identity **324** as well as public user identity **332**.

Public user identity **322** is associated with a service profile **340** and public user identity **324** and public user identity **332** share a service profile **342**.

Thus, as seen in FIG. **3**, the IMS subscription may have various private user identities and public user identities that are associated with one or more of the private user identities.

There is no authentication associated with public user identities **322**, **324** or **332**. Policing of what user identity can be used by the UE is performed by the HSS downloading via S-CSCF into the P-CSCF the public user identities that can be used by the device. When the device originates a session, the P-CSCF will ensure only valid public user identities are used.

When the IMPU is registered with the IMS network, the HSS will download to the S-CSCF a service profile. Service profile such as service profile **340** or **342** from FIG. **3**, describe under what circumstances the IMS application servers should be involved in a call/session. For example, the servers may be involved in the execution of services associated with the public user identity and will be controlled by the S-CSCF.

As identified above, the IMS authentication mechanism is called IMS AKA. IMS also allows for other authentication schemes to be supported including, but not limited to, SIP Digest, Transport Layer Security (TLS), GPRS-IMS-Bundled Authentication (GIBA). Network Access Subsystem (NASS)-IMS bundled authentication is also allowed to be used for authentication from either a fixed specific location or for early IMS deployments where IMS AKA is not available. GPRS IMS Bundled Authentication is another variant of NASS-IMS bundled, and is used for early IMS deployments. Such authentication schemes are, for example, described in 3GPP TS 33.203 in Sections N.1, O.1.1, R.1, and T.1.

However, there is no way to verify the public user identity. This presents issues in certain applications. For example, one application that this may present an issue with is mission critical push to talk (MCPTT), which is described below.

Mission Critical Push to Talk

Mission critical push to talk is a push to talk service used for mission critical type operations such as emergency services. However, it may also extend to commercial users including utilities, taxi cabs, among others. In some cases, MCPTT may be used anywhere that private mobile radio (PMR) systems are present today.

The MCPTT 3GPP service is described in 3GPP TS 22.179, "Mission Critical Push to Talk (MCPTT) over LTE; Stage 1", v. 13.1.0, March 2015, the contents of which are incorporated herein by reference.

As described in Section 4.5 of this specification:

> The MCPTT Service supports MCPTT User Profiles. The MCPTT User Profile contains important information related to the MCPTT User receiving the MCPTT Service, including the MCPTT User identity, which is globally unique and independent of the mobile subscriber identity (IMSI) assigned by a 3GPP network operator. Part of the content of the MCPTT User Profile (e.g., containing some display preferences, some UE audio settings, some address books) can be set/modified/updated by the MCPTT User, but significant portions might be set/modified/updated only by authorized persons. The MCPTT User Profile is stored permanently in database(s) associated with the infrastructure providing the MCPTT Service. Relevant parts of the profile might be downloaded to and cached temporarily or permanently on certain MCPTT Ues. When stored on an MCPTT UE, the MCPTT User Profile associated with an MCPTT User might be confidentiality and integrity protected, with the information available only to a trusted application client associated to the MCPTT

User, upon authentication. The MCPTT User Profile information can be synchronized automatically or on demand between the cache on the MCPTT UE and the main copy held in the database(s) of the MCPTT Service infrastructure. The MCPTT User Profile is part of the MCPTT application service domain and forms the basis of MCPTT application layer security and identifies an MCPTT User to the MCPTT Service. Each MCPTT User has at least one MCPTT User Profile, and possibly several. Typically, one of the MCPTT User Profiles is designated as the default MCPTT User Profile, to be used unless an MCPTT User Profile is explicitly selected. In general, a user profile is associated with a specific device, with a specific mode of operation (i.e., on the network or off the network) and/or with a specific situation (e.g., user being off-duty, in a certain city, or playing a certain role). When an MCPTT User Profile is synchronized between the infrastructure and an MCPTT device, information could be downloaded to the device and updated, as necessary. Subsequently and subject to permissions, the MCPTT User might choose a different associated MCPTT User Profile to be downloaded and stored on the device. Only one MCPTT User Profile is active at a time. Authorized users are allowed to create, delete and alter MCPTT User Profiles for an MCPTT User and/or pre-stored MCPTT User Profiles.

Further, Section 4.5.1 of the 3GPP TS 22.179 specification indicates:

Consistent with the EPS paradigm, when an MCPTT UE is powered on, it accesses the LTE system, and connects to the EPC. During this phase, the credentials from a USIM application (or possibly, an ISIM application, if IMS is used) on a UICC associated with the MCPTT UE is used for authentication with an HSS. This is followed by the MCPTT Application, resident on the MCPTT UE, establishing a connection, employing application layer security in its connection to the MCPTT Service.

Furthermore, as Section 4.5.2. of the 3GPP TS 22.179 specification states:

A user can enter his identifying/authenticating credentials (e.g., user name/password, PIN, biometrics, asserted identity from a remote, trusted device). This step typically gives the MCPTT User access to local information and applications stored on the MCPTT UE, and in particular, to the MCPTT client application.

The MCPTT Service allows the same MCPTT User to sign in (and stay simultaneously signed in) from different MCPTT Ues. For example, an incident manager or commander might use a portable phone, a command tablet, or a separate messaging unit.

Finally, Section 4.5.4 of this technical specification states:

The conceptual model for shareable MCPTT Ues is that of a pool of Ues, each UE being interchangeable with any other, and users randomly choosing one or more Ues from the pool, each user for his temporary exclusive use. A shareable MCPTT UE can be used by user who can gain access to the MCPTT client application stored on it and can become an authenticated MCPTT User. A shareable MCPTT UE can serve only one MCPTT User at a time. An MCPTT User who signs into a shareable MCPTT UE that is already in-use causes the sign-off of the previous MCPTT User.

An MCPTT User can simultaneously have several active MCPTT Ues, which, from an MCPTT Service point of view, are addressable individually and/or collectively within the context of their association to the MCPTT User.

From the above technical specifications, various things may be deduced. One requirement, for example, is that users from a first group could use devices that belong to a second group. For example, police in France may be able to use devices that belong to the police in the Netherlands.

One example of MCPTT architecture is provided in 3GPP TS 23.779, "Study on application architecture to support Mission Critical Push To Talk over LTE (MCPTT) services", v.0.5.0, February 2015, and is shown, for example, in FIG. 5.2.1.1.1-1 of that specification, the contents of which are incorporated herein by reference. In particular, public safety users may have their own applications in a server or group of servers. Such applications may include applications that communicate with the S-CSCF of the IMS network and include a PS-UDF (public safety-user data function) which is operated by the Public Safety Administration and functions as a type of "mobile virtual network operator" and provides the functions of the HSS required by the IMS and the public safety application. Thus the PS-UDF, replaces the HSS.

Due to the replacement of the HSS, roaming with traditional virtual public land mobile networks (VPLMNs) could be required. However in some embodiments, EPC level security uses traditional HSS while the Public Safety Administration uses a PS-UDF.

Other applications that may be part of a public safety authority server may include a MCPTT server. In this case, the PS-UDF provides authorization for mobile terminated call/session establishment and service invocation an updates the S-CSCF with filter criteria to trigger the services to be provided to the user by public safety application servers. The PS-UDF communicates with the MCPTT server and a group management function to support MCPTT services in the IMS. In one embodiment, the MCPTT server is equivalent to a push to talk over cellular (PoC) server in the open mobile alliance (OMA) push to communicate for public safety (PCPS) architecture.

From the above, the architecture of the public safety service includes one or more servers which communicate with the IMS system through the S-CSCF and include a PS-UDF and a MCPTT server.

In operation, MCPTT may be deployed as described in FIG. **4**. In particular, as described in FIG. **4**, a public safety operator may have an applications infrastructure **410**, as well as a SIP IMS core supporting the public safety operator **412**.

A regular PLMN may then be used for certain signaling including an IP (EPC) core supporting the public safety operator **420**, as well as an access network such as LTE **424**.

A public safety UE **430** may include a group management client **432** as well as an MCPTT client **434**.

As seen by FIG. **4**, control signaling between the applications infrastructure of the public safety authority provide control signaling to a group management client **432** as well as the MCPTT client **434**.

Further, user data and embedded control are provided to the MCPTT client **434** from applications infrastructure **410**.

In one use of the deployment model of FIG. **4**, full control of the IMS layer may be provided in which a cellular operator does not know what device is being used for, or by whom. In this case, the device would have a generic public user identity that would be used in the cellular network. However, in the IMS network this identity would be changed with no visibility of the change to a cellular operator.

Extensible Authentication Protocol

Extensible Authentication Protocol is an extensible authentication framework. It provides the necessary tools to incorporate other authentication schemes into the basic messaging structure. There are a number of EAP mechanisms that have been created. One EAP mechanism is the EAP-tunneled transport layer security (TTLS). In this authentication scheme a client can be securely authenticated with an authentication, authorization and accounting (AAA) infrastructure by setting up a secure tunnel between the client and a TTLS server, and then within a secure tunnel allowing another authentication protocol to be used to authenticate the client.

EAP-TTLS is, for example, described in the Internet Engineering Task Force (IETF) request for comments (RFC) 5281 "Extensible Authentication Protocol Tunneling Transport Layer Security Authenticated Protocol version 0", August 2008, the contents of which are incorporated herein by reference. Reference is now made to FIGS. **5**A and **5**B, which show protocol stacks from Section 6 of RFC 5281.

In particular, as seen in FIG. **5**A, when the user authentication protocol is not itself the EAP, EAP-TTLS packets are encapsulated within the EAP and the EAP in turn requires a carrier protocol to transport it. EAP-TTLS packets themselves encapsulate TLS, which is then used to encapsulate attribute-value pairs (AVPs), which may carry user authentication or other information. Thus, as seen in FIG. **5**A, the protocol stack includes a carrier protocol layer **510**, an EAP layer **512**, an EAP-TTLS layer **514**, a TLS layer **516** and an EAP layer **518**.

When user authentication protocol is itself an EAP, the protocol stack is shown with regard to FIG. **5**B. In particular, as seen in FIG. **5**B, the protocol stack includes an EAP layer **530**, an EAP-TTLS layer **532**, a TLS layer **534** and a layer **536** for AVPs including EAP. However, the protocol stack further includes an EAP method layer **538** in which methods for encapsulating EAP within carrier protocols are already defined. For example, point to point protocol (PPP) or Extensible Authentications Protocol over LAN (EAPOL) may be used to transport EAP between a client and an access point RADIUS or Diameter are used to transport EAP between access point and TTLS server.

IMS Authentication for MCPTT

Thus MCPTT requires that any users should be able to pick up any device and use it. For example, a fire station may have a box of devices that any firefighter may be able to pick up and use. Further, the authentication of the MCPTT application needs to be independent of the cellular/IMS network to meet the security requirements of the Public Safety service provider and Public Safety users and in some instances it may be desirable to hide or obscure the identity or the role of the user that is using a device. Thus, MCPTT does not fit well within the current IMS authentication protocols.

In accordance with the embodiments of the present disclosure, various authentication schemes are described for providing separate public and private user identities. Further, methods and systems for obscuring the identity of the user are also described. While the disclosure below is described with regard to MCPTT, the use of the authentication systems and methods described below can equally be used for other applications. Thus the present disclosure is not limited to MCPTT.

In the embodiments described below, solutions are provided for both in band signaling and out of band signaling. As used herein, in band signaling implies signals that utilize existing IMS messaging for authenticating an IMS UE that are enhanced to carry additional information to indicate a new form of authentication needs to be performed. Further, as used herein, out of band signaling implies that a new signaling path is used other than that of the current signaling path used to authenticate the IMS UE. In other words, the out of band signaling implies that the signaling currently used to authenticate the IMS UE is not enhanced and another mechanism is used to authenticate an individual subscriber.

Various in band and out of band embodiments are provided below.

The embodiments described below are provided as complete embodiments. However, one skilled in the art will appreciate that parts of each solution can be used with other solutions to form other potential solutions. In addition, some encoding mechanisms are shown with specific implementations. However, the specific implementations can be mixed and matched across the various solutions. In addition, various changes to standards are described in Appendices and tables. These show other specific embodiments and can equally be mixed and matched. One skilled in the art will appreciate that such example changes are used for illustrative purposes as well and the coding could be equally done numerous other ways.

In Band-Indication for Double Authentication

In one embodiment, an IMS registration message is enhanced to contain a new indication. The new indication signals to the network that instead of only authenticating the IMS Private User Identity (1st authentication mechanism), that the IMS Public User Identity authentication also needs to be performed (2nd authentication mechanism). The indication may be sent to authentication databases such as the HSS or PS-UDF to indicate that two sets of authentication vectors are needed at the UE.

Reference is now made to FIG. **6**. In the embodiment of FIG. **6**, UE **610** wishes to be authenticated with the IMS system. Communications may proceed through a P-CSCF **612**, an S-CSCF **614**, an AAA **616**, an HSS **618** and a PS-UDF **620**. The logical elements of FIG. **6** however may be rearranged and certain logic may be placed in other elements and therefore FIG. **6** is merely an example. For example, the AAA server could be combined with the PS-UDF. In another example, the PS-UDF could be combined with the HSS. Other examples are possible.

In FIG. **6**, as well as in the remainder of the specification, various network nodes are identified, for example as MCPTT server, PS-UDF, HSS etc. However, in general each of these entities may be considered as one of several network nodes interacting with each other to perform the methods described herein.

In the embodiment of FIG. **6**, the UE **610** sends a message **630** to the P-CSCF **612**. The message **630** contains various information including, but not limited to, a first public user identity, a first private user identity, and an indicator that indicates "double authentication" (Authentication of Private and Public user ID) is supported or needed. In one embodiment, the identifier of message **630** may be encoded as a new mechanism/name identifying a new security method. For example, such method may be referred as IPSEC-MCPTT. Alternatively, or in addition, the identifier may be coded as mech-parameters in a security-client field, for example, as described in IETF RFC 3329.

In an alternative embodiment, the identifier in message **630** may be a new parameter in the authorization header field. For example, a new AKA version number may be used.

In a further embodiment, the identifier may be encoded as an option tag in the supported or required header fields.

In a further embodiment, the identifier may be encoded as a feature tag.

Further, the identifier may be encoded as a universal resource identifier (URI) parameter such as, for example, "doubleauthentication=yes".

In a further embodiment, the identifier may be encoded as an extensible markup language (XML) body. It may also be encoded as a new header or may be appended to either the first public user identity or a first private user identity.

For example, in Table 1 below, items in bold represent some coding of the various methods described above. Table 1 below shows the various options all placed within the same registration message. However, one skilled in the art would know that in some circumstances only one identifier is needed and could be any of those shown in bold below. In other circumstances there could be a plurality of indicators.

TABLE 1

Possible Changes to an IMS Registration Message

```
REGISTER sip:registrar.home1.net;\doubleauthentication=yes SIP/2.0
Via: SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd];comp=sigcomp;branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip: home1.net!user1 public@doubleauthentication>;tag=4fa3
To: <sip: home1.net!user1 public@doubleauthentication>
Contact: <sip:[5555::aaa:bbb:ccc:ddd];comp=sigcomp>;
expires=600000; doubleauthentication=yes
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest
username="home1.net!user1private@doubleauthentication",
realm="registrar.home1.net", nonce="", uri="sip:registrar.home1.net",
response="",
Security-Client: ipsec-MCPTT; alg=hmac-sha-1-96; spi-c=23456789;
spi-s=12345678; port-c=2468; port-s=1357
Require: sec-agree
Proxy-Require: sec-agree
CSeq: 1 REGISTER
Supported: path
Content-Length: 0
Or
REGISTER sip:registrar.home1.net SIP/2.0
Via: SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd];comp=sigcomp;branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip:user1_public1@home1.net>;tag=4fa3
To: <sip:user1_public1@home1.net>
Contact: <sip:[5555::aaa:bbb:ccc:ddd];comp=sigcomp>;
expires=600000
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest username="user1_private@home1.net",
realm="registrar.home1.net", nonce="", uri="sip:registrar.home1.net",
response=""
Security-Client: ipsec-3gpp; alg=hmac-sha-1-96; spi-c=23456789;
spi-s=12345678; port-c=2468; port-s=1357
Authorization: Digest username="user1 public@home1.net",
realm="registrar.home1.net", nonce="", uri="sip:registrar.home1.net",
response=""
Security-Client: ipsec-MCPTT; alg=biometric finger prnt;
spi-c=23456789; spi-s=12345678; port-c=2468; port-s=1357
Require: sec-agree
Proxy-Require: sec-agree
CSeq: 1 REGISTER
Supported: path
Content-Length: 0
```

Similarly, 3GPP TS 24.229 may be changed in accordance with Appendix A attached hereto. As shown in bold in Appendix A, additions to the text of TS 24.229 are provided. However, as with Table 1 above, various changes are all grouped into the Appendix A and one skilled in the art will appreciate that only one change or a sub-combination of the bold changes may be needed in practice.

Referring again to FIG. **6**, once P-CSCF **612** receives message **630**, it sends message **632** containing the contents of message **630** to S-CSCF **614**.

S-CSCF receives message **632** and sends an authentication request message **634** to HSS **618**. One example of the changes that may be made for message **634** in the 3GPP TS 29.228 Specification are provided in Appendix B in bold. As seen in Appendix B, the description of the authentication may include biometric fingerprint data and IMS-AKA authentication, as examples. However, the changes in Appendix B are merely meant as examples.

An alternative embodiment is shown with regard to Appendix C, where the S-CSCF recognizes the second authentication digest header and includes a new MCPTT SIP authentication scheme attribute value pairs (AVP) with the indication of the authentication scheme to be used.

Specifically, as seen in Appendix C, an entirely new authentication scheme is defined.

A 1^{st} database function, e.g. HSS **618** receives message **634** and may then obtain authentication vectors from the 2^{nd} database function e.g. PS-UDF **620**, as shown by messages **636**. Specifically, the HSS may obtain the set of vectors for a public user identity number from the PS-UDF as shown with regard to message **636** in FIG. **6**. The HSS will send the authentication request message to the PS-UDF containing any or all of the data as identified above.

With regard to implementation, the HSS **618** may in some embodiments be combined with the PS-UDF **620**.

The PS-UDF **620** receives the public user identity and will respond with a set of vectors. Vectors can include one or more of the following challenges, although the challenge response is not restricted to the examples below. Specifically, an example set of vectors based on AKA are:

$AV=RAND_n||AUTN_n||XRES_n||CK_n||IK_n$ where:

RAND: random number used to generate the XRES, CK, IK, and part of the AUTN. It is also used to generate the RES at the UE.

AUTN: Authentication token (including MAC and SQN).

XRES: Expected (correct) result from the UE.

CK: Cipher key (optional).

IK: Integrity key.

The vectors could however be different based on the algorithm being used. For example, the vectors may be based on the data communicated in the SIP register, which is then converted into an entry in Appendix B. A message such as: Security-Client: ipsec-MCPTT; alg=biometric finger pmt; spi-c=23456789; spi-s=12345678; port-c=2468; port-s=1357 could be used.

Implementation wise the PS-UDF may be combined with the MCPTT server **619** or the AAA server **616**.

The HSS **618** may then provide the challenge vectors back to the S-CSCF **614** in message **640**. The challenge vectors in message **640** can be for the first private user identity and first public user identity. Challenge vectors for the first public user identity may be encoded as any one of a feature tag; XML body; AVP; or new header, among other possibilities. For example, Appendix D shows one possible change in bold to 3GPP 29.228 for an AVP challenge.

In the embodiment of FIG. **6**, the HSS has therefore included a second set of authentication vectors due to identification of a double authentication scheme. The data that then follows this information element is associated with the first public user identity. In the change in Appendix D, the last four rows are data items associated with the second IMS AKA function but the authentication mechanism could be any authentication mechanism. Thus, the SIP-authenticate shown in the Appendix D contains a challenge that is presented to a first public user identity. In addition, there is also a data item that the first public user identity can use to ensure it is being challenged by an authorized entity.

The SIP-authorization elements in Appendix D are the expected results to the challenge. S-CSCF **614** receives message **640** and provides message **642** to P-CSCF **612**. Message **642** provides the challenge vectors for both the private user and public user identities. For example, as seen in Table 2 below, the bold section provides an addition to the message for authentication. The bold section represents the 2^{nd} set of authentication vectors.

TABLE 2

Possible Changes to an Authenticate Request
SIP/2.0 401 Unauthorized
Via: SIP/2.0/UDP icscf1_p.home1.net; SIP/2.0/UDP
branch=z9hG4bK351g45.1,
pcscf1.visited1.net;branch=z9hG4bK240f34.1, SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd];comp=sigcomp;
branch=z9hG4bKnashds7
From: <sip:user1_public1@home1.net>;tag=4fa3
To: <sip:user1_public1@home1.net>; tag=5ef4
Call-ID: apb03a0s09dkjdfglkj49111
WWW-Authenticate: Digest realm="registrar.home1.net",
nonce=base64(RAND + AUTN + server specific data),
algorithm=AKAv1-MD5,
ik="00112233445566778899aabbccddeeff",
ck="ffeeddccbbaa11223344556677889900"
WWW-Authenticate: Digest realm="registrar.home1.net",
nonce=base64(CHALLENGE +
AUTHN server specific data),
algorithm=biometric finger prnt,
ik="00112233445566778899aabbccddeeff",
ck="ffeeddccbbaa11223344556677889900"
CSeq: 1 REGISTER
Content-Length: 0

In Table 2 above, the second nonce is a construct of various sets of data that are similar to the 1st nonce. The use of such second nonce is merely for illustrative purposes and one skilled in the art will appreciate that what is important is that the second nonce contains a challenge and additional data to verify if the challenge has come from a legitimate source.

P-CSCF **612** receives message **642** and forwards challenge vectors for the public user ID and private user ID to UE **610**, as shown by message **644**. Message **644** will typically contain the nonce, the algorithm to use, the second nonce and the second algorithm associated with the second nonce.

For example, reference is made to Table 3, which shows in bold additions that may be made to a message **644**.

TABLE 3

Possible Changes to an Authenticate Request
SIP/2.0 401 Unauthorized
Via: SIP/2.0/UDP [5555::aaa:bbb:ccc:ddd];comp=sigcomp;
branch=z9hG4bKnashds7
From:
To:
Call-ID:
WWW-Authenticate: Digest realm="registrar.home1.net",
nonce=base64(RAND + AUTN + server specific data),
algorithm=AKAv1-MD5
Security-Server: ipsec-3gpp; q=0.1; alg=hmac-sha-1-96;
spi-c=98765432; spi-s=87654321; port-c=8642; port-s=7531

TABLE 3-continued

Possible Changes to an Authenticate Request
WWW-Authenticate: Digest realm="registrar.home1.net",
nonce=base64(CHALLENGE + AUTHN + server specific
data),
algorithm=biometric finger prnt
CSeq:
Content-Length:

When the UE **610** receives message **644** containing two authentication challenge vectors, the second set of challenge vectors may be encoded as a feature tag, XML body, AVP, new header or www-authenticate-header, among others.

The UE **610** contains both a mobile element (ME) and a UICC. The ME performs the first authentication. If a UICC is contained in the ME, then the authentication vectors may be sent across the ME-UICC interface.

Either after the first authentication or during the first authentication the ME will run the second authentication challenge and the second authentication challenge is described in detail below.

One example of a change to the 3GPP TS 24.229 specification to support such double authentication at the UE is shown with regard to Appendix E below. In particular, Section 5.1.1.5 of 3GPP TS 24.229 has been amended in the example of Appendix E to show that the UE can extract the challenge and authentication parameters and check the validity of the authentication parameter. If the authentication parameter is valid then the UE may execute the MCPTT application authentication.

Once the UE **610** has completed the first authentication, the UE may then send an authentication response **650** containing two responses. The second challenge response may be encoded as any one of: a feature tag; XML body; AVP; a second authorization header; a new header; or appended to the existing response value using a separator character eg, XXXXX yyyyyy, where XXXXX is the first response value and YYYYY is the second response value, among other options. Such response values can be any number of characters in length.

Reference is made to Table 4 below, which shows a second authorization header including that contained in the second response in bold. The user name is that of the first public user identity.

TABLE 4

Second Authorization Header
REGISTER sip:registrar.home1.net SIP/2.0
Via: SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp;
branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip:user1_public1@home1.net>;tag=4fa3
To: <sip:user1_public1@home1.net>
Contact: <sip:[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp>;
expires=600000
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest username="user1_private@home1.net",
realm="registrar.home1.net",
nonce=base64(RAND + AUTN + server specific data),
algorithm=AKAv1-MD5, uri="sip:registrar.home1.net",
response="6629fae49393a05397450978507c4ef1"
Authorization: Digest username="user1_public@home1.net",
realm="registrar.home1.net", nonce=base64

TABLE 4-continued

Second Authorization Header
(CHALLENGE + AUTHN + server specific data), algorithm=[biometric finger prnt], uri="sip:registrar.home1.net", response="6629fae49393a05397450978507c4ef1" Security-Client: ipsec-MCPTT; alg=hmac-sha-1-96; spi-c=23456789; spi-s=12345678; port-c=2468; port-s=1357 Security-Verify: ipsec-MCPTT; q=0.1; alg=hmac-sha-1-96; spi-c=98765432; spi-s=87654321; port-c=8642; port-s=7531 Require: sec-agree Proxy-Require: sec-agree CSeq: 2 REGISTER Supported: path Content-Length: 0

An example of a change to the 3GPP TS 24.229 for the response is provided in bold in Appendix F below.

As seen in Appendix F, the response is provided with a second calculated response appended to the first response, as shown in bold in Appendix F.

Message **650** is received at P-CSCF **612** and forwarded to S-CSCF **614**, as shown by message **652**. S-CSCF **614** may then perform, as shown by block **654**, a check of the expected responses. If both nonce and nonce2 successfully match those stored in the S-CSCF **614** at block **641** in FIG. **6**, the UE **610** will be registered for MCPTT services. If the second nonce does not match the value stored in the S-CSCF, the UE will only be registered for IMS services. If the first nonce does not match the one stored in the S-CSCF **614**, the UE **610** will not be registered for any services.

In an optional embodiment, if the S-CSCF **614** does not already have the stored vectors for the public user identity, a message **660** may be sent to HSS **618**. An example of message **660** is shown with regard to Appendix G, which shows proposed changes in bold to 3GPP TS 29.228.

HSS **618** or other authentication function e.g. PS-UDF receives message **660** and determines the request for authentication vectors is for the public user identity contained in the public user identity field. The determination is based on indications identified above. In particular, Appendix H shows potential changes in bold to provide for authentication request data in 3GPP TS 29.228.

The authentication function such as HSS **618** will either generate the authentication vectors, request another function to generate the authentication vectors by forwarding the message or using an alternative protocol. The authentication function such as HSS **618** then sends the authentication vectors for the public user identity. Potential changes to 3GPP TS 29.228 are shown in bold by Appendix I.

As shown in Appendix I, the public user authentication vectors are provided in the response. Thus, message **660** has the HSS including the site of authentication vectors for the public user identity via identifying a public-user-authentication. The data that then follows this information element is associated with the first public user identity. One skilled in the art will appreciate that the last four rows in Appendix I are data items associated with the second IMS AKA function but the authentication mechanism could be anything. Again, one aspect is that the SIP-authentication contains a challenge that is presented to the public user identity. For example, if a first public user identity is being authenticated, then the challenge is directed to that first public authentication user identity. In addition, there are data items in the first public user identity data items in the message that the first public user identity can use to ensure that it is being challenged by an authorized entity. Further, the SIP authorization fields in Appendix I are the expected results of the challenge.

Referring again to FIG. **6**, if the UE **610** has been registered for MCPTT services, the S-CSCF **614** may send message **662** containing an indication that the second authentication has been successful to the authentication function e.g. HSS, PS-UDF etc. This indication may be encoded as, but not limited to, a feature tag, XML body, AVP or new header, among others.

An example of an AVP that could be updated is shown with regard to Appendix J. As shown in bold in Appendix J, changes to the 3GPP 29.229 specification and in particular to Section 6.3.15 are provided.

Another example of a new AVP is shown with regard to Appendix K. In Appendix K the applications that are being registered for are identified in Section 6.1.3 of 3GPP TS 29.229, as shown in bold.

Message **662** may also be used if the UE has not been registered for public safety/MCPTT services and has only registered for either IMS services. In this case, the S-CSCF **614** may send message **662** containing information pursuant to 3GPP TS 29.228.

In FIG. **6**, once success has been confirmed with the S-CSCF **614**, a success message **670** may be provided to UE **610**.

In the above, when the UE receives data for the second authentication challenge, the UE needs to provide a response to the network. This may be performed either at the ME or an application on the UICC. The result may be generated by either an automated or a manual process. An automated response could utilize an external authentication token. The external authentication token could be swiped in a card reader in the ME, the ME could communicate via wireless mechanism to an authentication token, for example using Bluetooth™, near field communications (NFC), radio frequency identifier (RFID), among others. Basically the ME sends a message to an external node and the external node responds back to the ME with authentication credentials.

In a manual authentication, the ME provides an indication that could be any one of, but is not limited to, an audio, visual or other message. The ME receives data via keyboard, screen, movement of the ME, fingerprint reader, retina scanner, NFC, swipe car reader among other options. The data received is then used as the challenge response and encoded in, for example, a MIME type message.

Thus, from the above, the IMS registration message is enhanced to contain a new indication. The new indication signals to the network that instead of only authenticating the IMS private identity, the IMS public user identity authentication is also to be performed. The new indication is also sent to the authentication database to indicate that two sets of authentication vectors are required.

The network, upon receipt of the new indication, will respond with two sets of authentication vectors instead of one or a single set of authentication vectors is associated with the IMS public user identity if a security association already exists for the IMPI.

A device should be capable of receiving two sets of authentication vectors and upon successful validation of the IMS private user identity set, the device may then validate and run a second set of authentication vectors. The second set of authentication vectors could be a password or some other unique identification of the user such as fingerprint, QR-code from ID card, biometric data such as retina scan, among others.

A successful response from the device to the 1st set of authentication vectors may allow the device to perform limited functionality in the IMS network such as to receive configuration information.

A successful response to the 2nd authentication vector allows the device to be used by a particular user. The exact functionality is dictated by the filter criteria and service description characteristics associated with that public user identity that has been successfully authenticated.

In Band-Second Public User Id and Authentication Response

In accordance with a further embodiment of the present disclosure, IMS registration is performed as normal, including a first public user identity and a first private user identity. However, when the device responds to authentication challenge, it may also include new additional information in the challenge response including a second public user identity instead of the first public user identity that was sent in the initial IMS registration.

In some embodiments, the UE may also provide a challenge response for that second public user identity if it knows the challenge vectors for the public user identities. In particular, if the same challenge vector is utilized for the second public identity as was provided for the first identity, then the challenge response will be different but will be derivable at the network.

In one embodiment, the challenge response for the second public user identity could be a password or some other unique identification of the user such as a fingerprint, a QR code from an ID card or other biometric data such as a retina scan, among others. In some cases, the second public user identity may be sent either in clear text or may be encrypted or obscured by the device and therefore must be decrypted or unobscured by a network entity such as the HSS. If the second public user identity has been encrypted, an identifier may need to be provided during the IMS registration to indicate such encryption. Encryption can be based on a public key that is known to the device and the HSS, PS-UDF or Public Safety AAA server.

When the network receives the second public user identity that does not match the first public user identity, the S-CSCF may need to obtain authentication vectors for the second public user identity. If the challenge response for the second public user identity is correct for the second public user identity, the network responds at the second user identity as the one to be used for the device. However, if the challenge response is incorrect for the second public user identity, the network responds with the first public identity as the one to be used by the device.

Reference is now made to FIG. **7**. In FIG. **7**, UE **710** communicates with a P-CSCF **712**. Further elements of the network include an S-CSCF **714**, an AAA **716**, an HSS **718**, and a PS-UDF **720**. Again one skilled in the art will appreciate that these are logical functions and could be combined together.

In the embodiment of FIG. **7**, UE **710** wishes to register with an IMS network, for example a public safety IMS network. In this case, UE **710** provides message **730** to the P-CSCF **712** which provides a first public user identity and a first private identity. The P-CSCF **712** receives message **730** and forwards a message to S-CSCF **714**, shown by message **732**, which again provides the first user identity and the first private identity.

S-CSCF **714** then provides an authentication request **734** to HSS **718** and HSS **718** may obtain challenge vectors for the private identifier as and provide them to the S-CSCF **714** in message **740**. The challenge vectors may, in some instances, be obtained from the P-UDF **720**, as shown by arrow **741**.

The challenge vectors are then passed from S-CSCF **714** to P-CSCF **712** in message **742** and then to UE **710** in message **744**.

The UE **710**, upon receipt of the authentication challenge of message **744**, provides message **750** back to the P-CSCF **712**. If the UE supports MCPTT service then the message may contain information consisting of, but not limited to a first private user identity, a second public user identity and credentials associated with the second public user identity. An optional indication that the second public user identity and/or credentials has been encrypted may also be provided if such is the case.

The information in message **750** may be encoded to include a new mechanism-name identifying the new security method. For example this may be IPSEC-MCPTT and/or MEC-PARAMETERS in a security-client header field. For example, IETF RFC 3329 describes such encoding. Further, the encoding may be a new parameter in the authorization header field such a new AKA version as described in IETF RFC 3310. Further, the information may be encoded as an option tag in the supported or required header fields, feature tags, URI parameters, XML body, new headers or appended to either the first public identity or first private user identity.

For example, reference is made to Appendix L which shows a potential change to the 3GPP TS 24.229, and in particular to Section 5.1.1.5 of this specification. The bold sections of Appendix L are those which are added.

Further, Table 5 shows potential changes in two implementations of messaging for providing for message **750**.

TABLE 5

Authentication Response
REGISTER sip:registrar.home1.net SIP/2.0
Via: SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp;
branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip:user1_public1@home1.net>;tag=4fa3
To: <sip:user1_public1@home1.net>
Contact: <sip:[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp>;
expires=600000
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest username="user1_public@home1.net",
realm="registrar.home1.net", nonce="public user authentication",
algorithm="public user authentication", uri="sip:registrar.home1.net",
response="6629fae49393a05397450978507c4ef1"
Security-Client: ipsec-MCPTT; alg=hmac-sha-1-96; spi-c=23456789;
spi-s=12345678; port-c=2468; port-s=1357
Security-Verify: ipsec-MCPTT; q=0.1; alg=hmac-sha-1-96;
spi-c=98765432; spi-s=87654321; port-c=8642; port-s=7531
Require: sec-agree
Proxy-Require: sec-agree
CSeq: 2 REGISTER
Supported: path
Content-Length: 0
For purposes of discussion the nonce in italics with be called nonce2.
A second implementation could look like following with the response
to the 1st challenge and second Authorization header with Public User
ID and response
REGISTER sip:registrar.home1.net SIP/2.0
Via: SIP/2.0/UDP
[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp;
branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip:user1_public1@home1.net>;tag=4fa3
To: <sip:used_public1@home1.net>
Contact: <sip:[5555::aaa:bbb:ccc:ddd]:1357;comp=sigcomp>;
expires=600000

TABLE 5-continued

Authentication Response

```
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest username="user1_private@home1.net",
realm="registrar.home1.net",
nonce=base64(RAND + AUTN + server specific data),
algorithm=AKAv1-MD5, uri="sip:registrar.home1.net",
response="6629fae49393a05397450978507c4ef1"
Security-Client: ipsec-3gpp; alg=hmac-sha-1-96; spi-c=23456789;
spi-s=12345678; port-c=2468; port-s=1357
Security-Verify: ipsec-3gpp; q=0.1; alg=hmac-sha-1-96;
spi-c=98765432; spi-s=87654321; port-c=8642; port-s=7531
Authorization: Digest username="user1_public@home1.net",
realm="registrar.home1.net", nonce="public user authentication",
algorithm="public user authentication", uri="sip:registrar.home1.net",
response="6629fae49393a05397450978507c4ef1"
Require: sec-agree
Proxy-Require: sec-agree
CSeq: 2 REGISTER
Supported: path
Content-Length: 0
```

P-CSCF **712** receives message **750** and forwards message **752** to the S-CSCF **714**. Message **752** includes the same information as message **750**.

In the example of FIG. **7** and as shown by Table 5, the S-CSCF sees that the information received does not match with the information provided in message **732** and which was subsequently stored. Such information may include the public user identity received in a username header, the nonce or the algorithm. The S-CSCF will then request authentication vectors from the authentication function such as the HSS **718** or the P-UDF **720** or the AAA **716** if it does not already have stored vectors for the public identity, shown by block **754**.

The obtaining of vectors is shown by message **756** and is the same as message **660** from FIG. **6** above with the exception that the information contains the second user identity.

As seen in FIG. **7**, message **752** provides the parameters and the authentication response to allow for a successful authentication of the second public user identity. Thus, once the authentication is checked from message **756**, if the authentication is successful then message **760** is provided between S-CSCF **714** and HSS **718**.

Further, a success message **762** may be provided to UE **710**, and such message may be the same as that provided as message **670** of FIG. **6**.

Conversely, if the authentication was not successful for the second public user identifier, then the message **770** includes success, but only for the first public user identifier, not the second public user identifier. Message **772** therefore provides for success but utilizing the first public user identifier.

The above therefore allows for the obscuring of a public user identity and the authentication of such second public user identity using in-band authentication mechanism for ISM.

In Band Keying Based on Public User Id

In a further embodiment, IMS registration from the UE is performed as normal with a new indication that authentication is also required for MCPTT or public user identification. This indication is sent to and from the S-CSCF and HSS/PS-UDF.

The key derivation process and challenge response process is enhanced to include a personal identification number (PIN) that is associated with the public user identity that is being used to access the system. The PIN is combined into the IMS AKA algorithm to create the authentication vectors.

The term PIN, as used herein, is being used in a generic fashion and can include, but is not limited to, a set of alpha numeric characters, a picture, iris scan, biometric data, fingerprint, voice print, key card, barcode, Qcode, a combination of some or all of the above, among other options.

Reference is now made to FIG. **8**, which shows information flow for such keying. In particular, UE **810** communicates with P-CSCF **812**, which communicates with S-CSCF **814**, AAA **816** and HSS **818**. In some embodiments, HSS **818** may also communicate with a PS-UDF.

As seen in FIG. **8**, the UE **810** sends message **830** including the public user identifier and private user identifier. This message is then forwarded from P-CSCF **812** to S-CSCF **814**, as shown by message **832**. The S-CSCF **814** may, upon receipt of message **832**, provide the authentication request to the AAA **816**, as shown by message **834**. AAA **816** provides the authentication request to HSS **818** in message **836**.

Challenge vectors are created and HSS **818** provides the challenge vectors for the private ID in message **840** to AAA **816**. The challenge vectors are then provided from AAA **816** to S-CSCF **814** in message **842**.

The challenge vectors are then forwarded from the S-CSCF **814** to the P-CSCF **812** in message **844** and finally provided to UE **810** in message **846**. UE, as described below, performs the authentication and provides an authentication response **850** back to the P-CSCF **812**. The authentication response is then forwarded to S-CSCF **814** as shown by message **852**.

If the S-CSCF **814** includes or has stored the challenge vector responses then a check may be made, as shown as block **854**. Otherwise, a response request may be made between the S-CSCF **814** and HSS **818**, as shown by message **860**.

If the authentication is successful then message **862** is used for the determination and message **864** is provided back to UE **810**.

In the above, the UE therefore sends a registration to the message to the network which includes an indication that authentication is performed for the MCPTT application. Such indication may be encoded as any one of: a new mechanism-name identifying a new security method such as ipsec-MCPTT and/or mech-parameters in a Security-Client header field; a new parameter in the Authorization header field; an option tag in the Supported or Require header fields; feature tags; URI parameters; XML body; new headers; or appended to either the first Public User Identity or the first Private User Identity. An example encoded in Table 6 below shows in bold the changes, where the new Security-Client has been called the "ipsec-3GPP-MCPTT".

TABLE 6

MCPTT Authentication Encoding

```
REGISTER sip:registrar.home1.net SIP/2.0
Via: SIP/2.0/UDP [5555::aaa:bbb:ccc:ddd];comp=sigcomp;
branch=z9hG4bKnashds7
Max-Forwards: 70
P-Access-Network-Info: 3GPP-UTRAN-TDD;
utran-cell-id-3gpp=234151D0FCE11
From: <sip:used_public1@home1.net>;tag=4fa3
To: <sip:user1_public1@home1.net>
Contact: <sip:[5555::aaa:bbb:ccc:ddd];comp=sigcomp>;
expires=600000
Call-ID: apb03a0s09dkjdfglkj49111
Authorization: Digest username="user1_private@home1.ner",
realm="registrar.home1.net", nonce="",
uri="sip:registrar.home1.net", response=""
Security-Client: ipsec-3gpp-MCPTT; alg=hmac-sha-1-96;
spi-c=23456789; spi-s=12345678; port-c=2468; port-s=1357
Require: sec-agree
Proxy-Require: sec-agree
```

TABLE 6-continued

MCPTT Authentication Encoding
CSeq: 1 REGISTER Supported: path Content-Length: 0

Further, at the UE, upon receiving message **846**, the UE may obtain a challenge response associated with the public user identity that was sent in the IMS registration message in the "from" header. The challenge response, which is referred to as the public user ID PIN, may then be sent into a function to modify it, either at the ME or UICC, and then from the ME the response may be sent across the ME-UICC to the UICC. The UICC may receive the public user ID PIN and use it to generate keys and challenge responses.

An example of potential changes to the 3GPP TS 31.103 specification are shown in bold in Appendix M below.

For the keying, S-CSCF **814** may be enhanced by sending the message to the authentication function to obtain authentication vectors. The message may include an indication that it is for an MCPTT service and may be encoded as a feature tag, XML body, new AVP, the use of an existing AVP with a new code point, or a new header.

The authentication function could be the HSS, AAA, PS-UDF or some combination of the three.

The authentication request may be in the form described in Appendix N below.

As seen in Appendix N, the authentication request may include a public user identity, private user identity, number of authentication items, authentication data, the S-CSCF name and routing information, among other information.

Upon receipt of a message requesting authentication vectors for the public user identity being registered, the authentication function obtains the private user ID PIN associated with the public identity in the public identity AVP. Using the indication sent by the UE in message **846**, the authentication function generates or requests authentication vectors and sends the response back within an indication of a new mechanism used to create the vectors. Such message may be encoded as, for example, a feature tag, XML body, new AVP, existing AVP using a new code point or a new header, among other options.

Reference is now made to FIG. **9**, which shows a possible key generation implementation.

In particular, the key generation includes an HSS process **910** which includes the generation of a sequence number (SQN) block **812** and a generation of a random number (RAND) block **914**. These are fed into various function blocks labelled as F**1** to F**5** and shown with reference numerals **920**, **922**, **924**, **926** and **928**.

In the embodiment of FIG. **9**, block F**1** **920** includes inputs of the SQN, authentication management field (AMF) and RAND, and further includes a key value K. An authentication token (AUTN) consists of SQN $\oplus$ AK||AMF||MAC.

Further, blocks F**2** to F**5** include the key value K along with the RAND as inputs.

In the embodiment of FIG. **9**, a new function F**6**, as shown by block **930** is also provided as an input to block **920**, **922**, **924**, **926** and **928**. Block **930** takes the public user id PIN as an input. The PIN may have been obtained from the PS-UDF (2^{nd} authentication function).

On the UE side **935**, the function f**6** is shown by block **840** and has the public user id PIN as an input. Output from block **940** is provided to function block F**1** **942**, as well as to block **944**, block **946**, block **948**. Further, an encryption key K is also provided to these blocks as well as to block **950**. RAND is provided also to block **950** and the SQN is derived at block **954**.

The UE can then verify that the MAC=XMAC and verify that the SQN is in the correct range. Thus, FIG. **9** shows the key generation process whereby the public user ID PIN is combined either with some or all of the F**1** to F**5**.

In order to hide the public user ID PIN, the PIN may also be sent through a function F**6**.

In Band-Keying Based on Public User Id, Alternative Embodiment

In an alternative embodiment, the output of the IMS AKA algorithm is now combined with the public user ID key to create a set of authentication vectors. In particular, the solution is similar to that above, but has the advantage that the operator of the HSS, which is traditionally a public operator carrier, does not get visibility of the public user ID PIN. This is achieved by combining the PIN with the private user ID authentication vectors in the AAA/PS-UDF instead of the HSS. The main difference between this embodiment and the embodiment above is the way in which the keys are generated, which is shown in FIGS. **10** and **11**.

In particular, reference is now made to FIG. **10**, which shows a diagrammatic view of the authentication vector generation in the HSS and AAA/PS-UDF. Note the HSS, AAA and PS-UDF could be a single node or multiple nodes.

An HSS process block **1010** communicates with an AAA/PS-UDF process block **1020**. Thus, in accordance with the embodiment of FIG. **10**, similar key generation blocks to those of FIG. **9**, including an SQN block **1012**, and RAND block **1014** are provided. Output from these blocks are input to function blocks **1030**, **1032**, **1034**, **1036** and **1038**. However, the output from blocks **1030**, **1032**, **1034**, **1036** and **1038** is provided to the AAA/PS-UDF process **1020** and thus the public user ID PIN is never used at the HSS. Instead, the public user ID PIN is provided for block F**6** as shown by block **1050** and can generate output for blocks **1060**, **1062**, **1064**, **1066**, and **1068**.

FIG. **11** shows a diagrammatic view of the authentication vector generation at the UE. In particular, the parameter key may be used as an input to function blocks **1110**, **1112**, **1114**, **1116**, and **1118**. Further, the SQN can be generated at block **1120**.

The public user ID PIN is provided at function block **1130** and may be provided. Along with outputs of blocks **1110**, **1112**, **1114** and **1116**, to blocks **1140**, **1142**, **1144**, and **1146**.

Thus the use of the public user id PIN may be kept secret from the carrier.

While the solutions of FIGS. **9**, **10** and **11** are provided above for in band solutions, they may be equally utilized with some of the out of band solutions described below.

Out of Band Signalling

In a further embodiment, out of band signaling may be used for authenticating an IMS individual subscriber. Out of band signaling implies that a new signaling path is used than the signaling currently used to authenticate the IMS UE. The out of band signaling mechanism can be used either before or after IMS registration.

In a first embodiment, the device may signal to a network a first authentication procedure. This may, for example, be an EAP message that authentication is required. The message may contain the public user identity for which the authentication is required, and optionally the private user identifier that the public user identifier is associated with. The network may respond with an authentication challenge that is appropriate to the EAP authentication mechanism being used.

Upon successful authentication of the public user identity, the UE then provides the same public user identity in an IMS registration message to the network as well as the private identifier used in the first authentication procedure (if it was provided at all). This is known as the second authentication procedure in the description below.

The network will then check that the public user identity has been successfully authenticated and signal the public user identity back in the response to the registration. If authentication of the public user identity was unsuccessful, the network may respond with another default public user identity that is used for configuration purposes or may allow the user a limited ability to contact staff to fix authentication problems, for example. Alternatively, the network may respond with an authentication failure indication.

Keys for the second authentication mechanism may be generated, for example, utilizing the techniques described above with regard to FIGS. **9**, **10** and **11**.

Thus, in accordance with one embodiment of the present disclosure, the out of band solution links the public and private user IDs together. This means that only the public user ID can be used with a specific private user ID after the public user ID has been first authenticated.

Reference is now made to FIG. **12**. In FIG. **12**, a UE **1210** communicates with a P-CSCF **1212**. Further, various elements may include a S-CSCF **1214**, an AAA **1216** and an HSS **1218**. In some embodiments, a PS-UDF (not shown) may also be provided and could be co-located with the AAA **1216** and/or HSS **1218**.

In the embodiment of FIG. **12**, a first authentication mechanism **1220** is shown to be performed first. A second authentication mechanism **1222** is then shown to be performed. However, in other embodiments the second authentication mechanism **1222** could equally be performed first and the first authentication mechanism **1220** performed subsequently. In this case, in one embodiment the response to the public user identity authentication in the first authentication mechanism may need to already be available to the UE and HSS for the second authentication.

The first authentication mechanism **1220** comprises various messages. A first message **1230** sent from UE **1210** to AAA **1216** typically contains at least of a public user identity and optionally a private user identity.

AAA **1216** receives message **1230**. If message **1230** does not contain two identities, then the network may send message **1232** back to UE **1210** to either request both the public user identity and private user identity or, in other embodiments, to request only the public user identity.

One example of a change to the 3GPP TS 24.302 specification to allow for the request of message **1232** is provided in Appendix O. As seen in Appendix O, an octet may be used to indicate the request for the various identities back to the UE.

Referring again to FIG. **12**, once the UE receives message **1232**, the UE determines whether or not to send one or both identities. If only one identity is sent back, EAP-AKA supports the sending of this one identity already.

In one embodiment, the UE will additionally send a second identity using a new encoding scheme. For example, referring to Appendix P, a possible change to the 3GPP TS 24.302 is provided in which the alternative encoding scheme is provided.

The UE will then send message **1234** back to the network, for example to AAA **1216**. However, in other embodiments the receiving party may be the PS-UDF or MCPTT AS or HSS **1218**.

Once the network receives message **1234**, it may then provide a message to HSS **1218** containing both the private user ID and public user ID, as shown by message **1240** in FIG. **12**. HSS **1218** receives message **1240** and generates authentication vectors for the public user ID and provides these back to AAA **1216** in message **1242**. As described in previous in band embodiments and other out of band embodiments, the HSS can communicate with the PS-UDF to obtain authentication vectors. In addition the HSS maybe a PS-UDF.

The AAA **1216** receives message **1242** and forwards the challenge vectors to UE **1210** in message **1244**.

UE **1210** receives message **1244** and generates an authentication response, which is provided back to AAA **1216** in message **1250**.

AAA **1216** receives the authentication response and forwards it to the HSS **1218** in message **1252**, which then checks the authentication response and provides a result back in message **1254**.

If message **1254** is a success message, the success may then be forwarded to UE **1210** in message **1256**.

At this point, the first authentication mechanism **1220** has been successful. In this case both the UE and the HSS mark the public user ID as the one to use against the private user ID, as shown by block **1260** for the UE **1210** and block **1262** for the HSS **1218**.

The process of FIG. **12** then proceeds to the second authentication mechanism **1222**. From a UE perspective, the UE performs IMS registration per 3GPP TS 24.229 and includes the public user ID and private user ID determined in the first authentication mechanism **1220**.

When the UE receives the 401 k challenge from the network, it optionally uses the response it used for the public authentication in the first authentication mechanism **1220** in creating the response that is put in the SIP register to the network. For example, the mechanism of FIGS. **9**, **10** and **11** above may be utilized in which the response is the same as the public user identifier PIN.

From the HSS **1218** perspective, the HSS receives a request to provide authentication vectors. These authentication vectors may be created as described above with regard to FIGS. **9**, **10** and **11**, where the response for the public authentication in the first authentication step is the same as the public user ID PIN. The HSS then ties the public user ID to the private user ID. For example, a key overview is provided with regard to FIG. **13**.

In FIG. **13**, UE **1310** and HSS **1312** proceed through an authentication procedure. A first authentication process **1320** includes the public ID **1322** as an input from both the UE and HSS.

The result of the first authentication process at each of UE **1310** and HSS **1312** is provided to the second authentication process **1330** and particularly to an IMS AKA **1332** for the UE and IMS AKA **1334** for the HSS. Described another way, as part of the 1st Authentication Process the HSS **1312** sends a challenge to the UE **1310**. At the same time the HSS calculates the Response that it expects to get from the UE. The UE responds to the challenge with a response. The Response generated by the UE is used as an input into IMS AKA **1332** and the Response generated by the HSS is used as an input into IMS AKA **1334**.

The IMS AKA **1332** includes an input for the private identifier at the UE. Similarly, IMS AKA **1334** includes an input for the private identifier at the HSS.

The results of the second authentication processes (XRES) are provided to the S-CSCF **1340** which determines the success or failure.

The above therefore provides an out of band solution in which a public user ID is tied to a private ID prior to the IMS registration. However, as indicated above, the out of band authentication may also occur after IMS registration in some embodiments.

Second Out of Band Embodiment

In an alternative embodiment, the solution provided above with regard to the first out of band embodiment may be utilized. However, in a situation where a user of a first Public Safety Service provider is providing assistance to a second Public Safety Service provider and needs to use the

MCPTT service of the second public safety user provider, enhancements to the solution of FIG. **12** above may be made.

For example, if a first police officer of a first police force is assisting a second police force and needs to use the MCPTT service of the second police force, the embodiments described below with regard to FIG. **14** may be utilized. FIG. **14** may equally be used where first Public Safety Service provider is same as the second Public Safety Service provider.

In a second embodiment, the device performs a second authentication mechanism. For example such authentication mechanism may be the IMS registration with a second public user identity and a private user identity.

The IMS third party registration is then performed with the MCPTT AS. The MCPTT AS uses an enhanced Sh interface and sends an indication that the user identity has been now successfully registered for the MCPTT service.

The device may then perform a second authentication mechanism using a first public user identity via a secure tunnel that was created as part of the first IMS registration or could be part of a second authentication mechanism such as EAP-TLS.

The first public user identity is the public user identity the UE wants to use for communication. Upon successful authentication, the PS-UDF over an enhanced Sh interface signals that the first public user identity and private user identity have been successfully authenticated for the MCPTT service.

Upon success of the second authentication, in one embodiment the device performs a second IMS registration using the first public user identity. In an alternative embodiment, when the network indicates a successful authentication back to the device, the network element, such as the HSS, updates the P-CSCF with the first public user identity. This could be either via an HSS-PCC-P-CSCF to modify the public user identities in the P-CSCF by using the PCC. Alternatively this may be used via HSS-S-CSCF where the Cx interface command or message that changes the public user identity in the profile in the S-CSCF triggers a NOTIFY for the registration event package to be sent to the P-CSCF to update the identities that can be used with the private user identity.

Thus when the device sends an INVITE, the P-CSCF will assert the first public user identity for any session originations.

The above therefore provides a way to trigger configuration mechanisms so that the UE can roam to a second MCPTT network and thus provide mutual aid.

Reference is now made to FIG. **14**. In the embodiment of FIG. **14**, a UE **1410** communicates with a P-CSCF **1412**. Further, an S-CSCF **1414** and an AAA **1416** are provided in the system.

Further, an MCPTT **1420**, HSS **1422** and PS-UDF **1424** are provided in the system.

In the embodiment of FIG. **14**, a second authentication mechanism **1430** is performed first. In particular, the IMS authentication registration **1432** utilizes a second public identity instead of a first public user identity. This registration process allows the UE to get basic IMS services but not MCPTT services.

The third party registration **1434** just registers the first private user identity and a second public identity with the MCPTT service. The MCPTT service then updates the PS-UDF **1424** with at least one of the private user ID, second public user identity, or device ID that have been registered with the MCPTT service.

The signaling for the above, may for example may be provided utilizing a change to the 3GPP TS 29.328. One example of such change is shown, with regard to Appendix Q.

As seen in Appendix Q, the IMS user state may be registered for a particular service such as an MCPTT or not registered for a particular service such as MCPTT.

Once the second authentication mechanism in which the second public user identifier has been used is completed, a third party register message may be provided between the MCPTT **1420** and S-CSCF **1414**, as shown by message **1434** and a subscriber message **1436** may be provided between P-CSCF **1412** and S-CSCF **1414**.

Subsequently, the first authentication mechanism **1440** may be performed. The first authentication mechanism **1440** is the same as that provided above with regard to the first authentication mechanism **1220** of FIG. **12**. In particular, the first authentication mechanism utilizes a first public user identity and a first private user identity for the authentication. This is shown by message **1442** which is passed to the AAA **1416**. The first public user identity and private user identity are then provided to the PS-UDF **1424** in message **1444**.

Challenge vectors are then provided for the first public user ID, as shown in message **1446**, to AAA **1416**. AAA **1416** then provides these challenge vectors to UE **1410** in message **1448**.

The UE then provides an authentication response shown by message **1450** to AAA **1416**. The authentication response is forwarded to the PS-UDF **1424** in message **1452**. If the authentication process is successful, the PS-UDF **1424** (or the AAA in some cases) updates the MCPTT server **1420**, as shown by message **1460** via the Sh interface. An example message is shown with regard to Appendix K, as described above. The message on the Sh interface contains the 1^{st} Public User Identity and optionally the first private user identity. The MCPTT server is then able to correlate that the 1^{st} Public User identity has been registered from the same device the 2^{nd} Public User identity was registered from in the 2^{nd} authentication mechanism. Equally the Sh interface can be used so the MCPTT server can provide the first private user identity and 2^{nd} Public User identity to the PS-UDF so it can create a relationship between 1^{st} Public User identity, 2^{nd} Public User identity and first private user identity. The PS-UDF can then update the HSS with this relationship, as shown by message **1474**. The term “update” as used herein means that the HSS may query the PS-UDF to determine if 1^{st} Public User identity can be used with the first private user identity, or PS-UDF provides information to the HSS so that it can create a relationship between 1^{st} Public User identity, 2^{nd} Public User identity and first private user identity.

Messages **1464** and **1466** may be provided to show success. In particular message **1464** is provided from PS-UDF **1424** to AAA **1416**. The message **1466** is provided from AAA **1316** to UE **1410**.

The Sh notification could be enhanced to provide an indication that authentication for the MCPTT service has been successful. An example message with enhancements is shown in Appendix R below.

As seen in Appendix R, possible changes to 3GPP TS 29.328 are provided which allow for a device to be registered or not registered for the service X (can be MCPTT or PTT). Further, the information element contains a device ID of the device that the IMS user has registered for the MCPTT services.

After the first authentication mechanism, a second authentication mechanism **1470** may occur as described above with regard to the second authentication mechanism **1222** of FIG. **12**.

Further, once the first authentication step has been successful the HSS **1422** then updates the network to use different public user identity, two optional elements are provided. In a first optional mechanism, the HSS **1422** may update the PCC **1482** with an updated PCC message **1484**. The PCC may then update the P-CSCF **1412** in message **1486**.

The P-CSCF **1412** may then translate incoming messages. Thus, the UE **1410** may send an INVITE **1488** with the second public identity and this invite is then translated at P-CSCF **1412** to reflect the first identity, as shown by message **1490**.

In a further alternative, HSS **1422** may modify the profile for the first public user identity, as shown by message **1494** which may be then notified to P-CSCF **1412** in message **1495**.

The UE **1410** may then provide an INVITE with the second user identity, shown by message **1496**, which may be translated by the P-CSCF **1412**. P-CSCF **1412** may then forward the INVITE, but having the first user identity, as shown with message **1498**.

Out of Band Mutual Aid

In a further embodiment of the out of band solution, a first authentication mechanism is performed in which additional enhancements allow a network to request, and the UE to provide, information regarding the PLMN it is registered on in the authentication mechanism. This PLMN information is then used to determine which public service safety provider should be contacted.

A new message is sent from the MCPTT server of the first public safety operator to the PS-UDF of the second public safety operator to request a private user ID. It may be that such message includes the public user ID of the user being authenticated.

The PS-UDF of the second public safety operator then provides back the private user ID and public user ID. This information may be then sent to the UE via messaging such as open mobile alliance (OMA) device management, hypertext transfer profile (HTTP), XML Configuration Access Protocol (XCAP), or over the air (OTA) message to the USIM or ISIM application, where new fields are present that store this information.

The UE may then perform a second authentication mechanism using the new private and public user identifiers. When the PS-UDF of the second safety operator receives the second authentication mechanism, it then contacts the PS-UDF of the first public safety operator to obtain the credentials and uses them to authenticate the user.

Reference is now made to FIG. **15** in which a UE **1510** communicates through a TTLS/IPSec server **1512** with a PS-UDF **1514** and MCPTT server **1516** of the first MCPTT operator **1520**. An S-CSCF **1522** of PLMN **1524** is utilized for the MCPTT of the first operator **1520**. Note that TTLS/IPSec server **1512** could be combined with either or both of the PS-UDF **1514** and MCPTT server **1516**. Such an implementation is shown as a dotted line **1590**.

A second MCPTT operator **1526** has a second PS-UDF **1528**.

In the embodiment of FIG. **15**, UE **1510** contains a first private user identity, a second public user identity, a device identity and a certificate that could be linked to the first private and/or public user identity.

A first authentication mechanism **1530** is provided. As part of an optional first part of authentication mechanism **1530**, UE **1510** could set up a TTLS/ipsec tunnel with a TTLS/ipsec server **1512**, as shown by messages **1532**. In one embodiment the TTLS/ipsec server could be an AAA server, a PS-UDF or an MCPTT AS, or could be a combination of some or all of these servers.

The UE **1510**, as part of the tunnel setup, includes a certificate. Possible certificate mechanisms are described below. The certificate may have a relationship between the device and/or private user ID being used with that device. As part of such mechanism, the network may request specific attributes from the UE. Such attributes may include, but are not limited to: an identity that identifies the user equipment and a network that the UEs registered on.

These attributes are requested by sending a request from the network to the UE. If the TTLS/ipsec server **1512** communicates with a AAA server (not shown) or a PS-UDF, then the AAA server or the PS-UDF could send the attribute request via the TTLS/ipsec server to the UE. Or, if all of the servers are combined in a network node then the network node sends the request to the UE for the attributes.

EAP extension attributes may be provided for such request. These are, for example, shown in Appendix S, which shows that an octet may be used for requesting certain information.

A first authentication mechanism may then be used. Examples of such first authentication mechanisms are described above with regard to FIG. **12** or **14**.

As shown by message **1534**, the authentication mechanism may provide certain information. In one option the UE may send an identity including a second public user identity to be authenticated. Optional additional information to be sent may include, but is not limited to, a device identifier that identifies the equipment and/or a network that the UE is or was registered on. This additional information may be obtained by the network node, for example by PS-UDF **1514** sending a message to the UE. Such message may include indicators that ask for additional information, including for example the PLMN the UE is registered on, the device ID, among other information. The UE receives this message and sends a message to the network, for example to the PS-UDF, containing a device identifier that identifies the equipment and/or a network that the UE is or was registered on.

The additional information may be sent based on the receipt, at the UE, of the request of a message as shown in Appendix S.

Upon successful authentication, the PS-UDF **1514** sends an indication to the MCPTT AS **1516** that authentication for the second public user identity has been successful. This is shown in message **1536**. The first private user identity, first public user identity, second public user identity, PLMN and IMEI may also be indicated. The PS-UDF **1514** in one implementation could be the MCPTT AS. One example of possible changes to the 3GPP TS 24.302 specification for this are shown with Appendix T below. Note the first public user identity could have been derived from the certificate exchange that has taken place in authentication mechanism **1530** and is explained in more detail below.

Once the first authentication mechanism **1530** is finished, a configuration mechanism **1540** may occur. One skilled in the art will appreciate that the authentication mechanism shown in message **1534** can be exploded out to be that as described in but not limited to authentication mechanisms **1440**, **1220**, among others.

During the configuration mechanism, a message **1542** may be provided from UE **1510** to the MCPTT AS **1516**. Message **1542** may optionally provide a configuration request to the network. It may contain the PLMN identity of the network that the UE has registered on. This request may occur because the UE uses OMA management objects for configuration of the MCPTT identities.

MCPTT AS **1516** may then request a second private identifier and 3rd public user identity from the second MCPTT operator **1526** as shown by message **1544**. Message **1544** may contain 0 or more of: a first private user identity, a first public user identity, a second public user identity. The

MCPTT operator **1526** may be derived based on static configuration or by performing a DNS look up on the PLMN identity that the UE is registered with.

The second PS-UDF **1528** receives message **1544**. In one embodiment the MCPTT AS may only send the first public user ID to the second PS-UDF **1528** in order to ensure that the first private user ID is not released.

The second PS-UDF **1528** associates the second private user ID with the following, if received: the first private user identity; the first public user identity; the second public user identity; and/or the equipment identity.

PS-UDF **1528** sends at least one of the second private user identity and a third public user identity back in message **1546**. MCPTT AS **1516** receives at least one of the second private user identity and the third public user identity.

The UE may then be provisioned with data. A data model can be found in FIG. **16** below, where the UE is provisioned with the private identifier and public identifier. Those skilled in the art will appreciate that this is an example of an OMA Device Management (DM) Object that describes a set of data. However it can be equally used as an abstract data model. For example, the private identifier could be an IMSI as defined in E.212 or a network address indicator (NAI) as defined in RFC 4282. The public ID could be an MSISDN as defined by E.164 or an NAI as defined by RFC 4282 whereby the NAI also may contain a digit strings that represents the MSISDN.

A validity area for these identities that could be specific to a PLMN, a region within the PLMN, geographical area or even WLAN or combination thereof.

For the purposes of describing FIG. **16** the analogy of a book/novel shall be used. However, as identified, OMA DM describes the nomenclature of the diagrams in detail. Thus, referring to FIG. **16**, an MCPTT **1610** may have 0 to multiple pages, as shown by block **1612**.

In the embodiment of FIG. **16**, a question mark indicates an optional element. Thus, one option element includes a series of identifiers **1620**. Each identifier may either be a private identifier **1622** or a public identifier **1624**, and may include various paragraphs (e.g. sets of data items) **1626** and **1628** which may include IMSIs or private user identifiers or MSISDNs or public user identifiers. Note a set may contain 0 to many entries.

The pages may each also contain a validity area **1630**. The validity area may be based on a 3GPP location **1632**, a 3GPP2 location **1634**, a WLAN location **1636** or a geographic location **1638**, among others.

Each location may then have several criteria to make determinations. Thus, a 3GPP location may have various paragraphs **1640**, and may include information such as a PLMN, Type Allocation Code (TAC), Location Area Code (LAC), GSM Edge Radio Access Network (GERAN) Cell Identifier (CI), Universal Mobile Telecommunications Service (UMTS) Terrestrial Radio Access Network (UTRAN) CI, Evolved Universal Terrestrial Radio Access (EUTRA) CI, among other information.

A 3GPP2 location may have a check to determine if the connection is a 1× connection as shown by block **1650** in which case multiple paragraphs **1552** may be provided. Information in these paragraphs may include system ID (SID), network ID (NID) or a base ID.

Similarly, if the 3GPP location is high rate packet data (HRPD) as shown by block **1654**, then multiple pages **1656** may be provided. These pages may include information such as a sector ID or netmask.

A WLAN location **1636** may have various paragraphs **1662**. Information in these paragraphs may include a homogenous extended service set identifier (HESSID), a service set identifier (SSID), or basic service set identifier (BSSID), among other information.

A Geographic location **1638** may have a check to determine if it is a circular location shown by block **1670** in which case multiple paragraphs **1672** may be provided. Information in these paragraphs may include an anchor latitude, an anchor longitude, and a radius, among other information.

Further, the geographic location **1638** may check this to determine if the location is a polygon as shown by block **1684**, in which case multiple paragraphs **1686** may be provided.

Paragraphs **1686** may include including coordinates **1688**, which themselves have multiple paragraphs **1690**. Information in paragraphs **1690** may include latitude and longitude.

Referring again to FIG. **15**, once a MCPTT **1516** receives the information of message **1546** then a configuration may occur between the UE and the MCPTT, as shown with arrow **1550**. In arrow **1550**, if the USIM/ISIM is used, the MCPTT AS sends a message containing a least of, but not limited to, the second private user ID and the third public user ID, and optionally PLMN information.

In one embodiment, messages **1546** and **1550** are optional, and in this case, the MCPTT AS **1516** would need to generate the third public user ID. However, in this case the second private user ID would not be generated.

In the MCPTT AS **1516**, a mapping occurs between some or all of the following: a first private user identity; a first public user identity; a second public user identity; an equipment identity; a second private user identity; and a third public user identity.

Message **1550** could be short message service (SMS) message containing Over The Air (OTA) information. The over the air message sequence could include a USAT REFRESH command with a qualifier "MCPTT private user ID update".

The UE, upon receipt of the configuration information at message **1550** could decode the message. The SMS destination address could be second public user ID. In one embodiment Appendix U shows possible changes to the 3GPP TS 31.103 specification which could equally apply in 3GPP TS 31.102.

Further, the command details could be provided in accordance with Appendix V, which show possible changes to the ETSI TS 102 223 specification.

If the ME receives a USAT REFRESH command qualifier of type "MCPTT private user ID update", the ME can update the private identifier on the device.

Alternatively, if an OMA DM, HTPP or XCAP are used then the UE receives the configuration for the UE by sending a message to the network (e.g. MCPTT AS etc). The network will respond back with configuration information which can include one or more of a private ID, public ID and network code. The information that may sent is shown with regard to FIG. **16**.

Once the configuration mechanism **1540** is complete, a second authentication mechanism **1560** could occur. The second authentication mechanism **1560** includes a registration message **1562**. Such message may be a SIP Register containing the second private user ID and optionally a third public user identifier. If the second private user ID was not received in the configuration information of message **1550**, then the first private user ID would need to be used with the third public user identifier.

As will be appreciated by those in the art, the public and private user identifiers to use will be based on the PLMN that the UE is registered on. This means that if the ME may compare the registered PLMN (RPLMN) with the PLMNs in the validity area/3GPP location/<x>/PLMN leaf of FIG. **16**. If there is a match then the public and private user ID that are used are associated with that PLMN. When the information is stored on the USIM/ISIM as shown in Appendix

U the ME will compare the RPLMN with the PLMN field and choose the appropriate data.

The S-CSCF receives message **1562** and may optionally provide message **1564** to PS-UDF **1528**. Message **1564** only occurs if the second private user identity has been used in message **1562**. The second PS-UDF **1528** receives message **1564** and PS-UDF **1528** may use this information to create a mapping. Message **1566** may then be sent to MCPTT **1516** to obtain the authentication vectors for the first private ID if available, otherwise for the first public user ID. For example, message **1566** contains within its contents the first private ID if available and or the first public user ID.

MCPTT **1516** receives the message, and sends message **1570** to the PS-UDF **1514** requesting authentication vectors for the first private ID if available and/or the first public user ID. If the first public user ID was received, the MCPTT AS will use the mapping created above to determine the private user ID.

PS-UDF **1514** receives message **1570** requesting authentication vectors and generates the vectors. PS-UDF then sends message **1572** containing the authentication vectors for the first private user ID back to MCPTT **1516**.

The MCPTT **1516** receives message **1572** containing the authentication vectors for the first private user ID and sends the message to the second PS-UDF **1528**, as shown by message **1574**. The second PS-UDF may then generate vectors for the third public user identity and second private user identity and these may be forwarded to the UE, as shown by messages **1580** and **1582**.

As will be appreciated by those skilled in the art, FIG. **15** is merely an example. In alternative embodiments, the UE may perform the second authentication first, using the private user identity and public user identity stored on the UE. The UE may then perform the first authentication mechanism subsequently.

Further, in the context of the disclosure above, a second authentication mechanism is described in numerous embodiments with labels **1222**, **1430**, **1470**, **1560**. One will appreciate that the examples are based upon the SIP REGISTRATION procedure that as also includes an optional authentication component. Such SIP registration process has been described above with regards to FIG. **2**. Per 3GPP TS 33.203, the 2nd Authentication mechanism starts by UE sending a SIP Register message to the network, the UE then receives a message from the network that contains the authentication challenge to which the UE will respond with another Register message.

Certification Generation Processes

In a further embodiment, instead of the enhancements to the protocols listed above to obtain private IDs, public IDs and device IDs, it is also possible to use certificates which could be used as well in conjunction with those embodiments described above.

The UE performs a first authentication mechanism procedure as described above and sets up a tunnel. After the tunnel has been set up, authentication of the first public user identity can take place using any authentication scheme. Examples of such authentication schemes include EAP, challenge handshake authentication protocol (CHAP), password authentication protocol (PAP), or message-digest 5 (MD-5), among others.

Thus, a first secure tunnel is set up between the UE and the network and then, within the tunnel, authentication of the public user identity takes place.

In the initial tunnel set-up a certificate may be provided. This, for example, could be an x.509 certificate. The certificate may be created in a new way in accordance with the description below. In one embodiment, the certificate may be pre-provisioned and may be linked to either the device ID or the private user identifier from the UICC.

The setting up of a tunnel creates a relationship in the network between the device and the private identifier. Then the public user identity authentication phase starts between the ME and the AAA server. If the AAA server is co-located with TTLS server, then there is a relationship in the TTLS server between the device ID, private ID, and public user ID. The TTLS/AAA server could be an IMS AS and in the context of the description above it may also be an MCPTT AS.

The UE performs a second authentication mechanism such as an IMS registration, which may take place either before or after the first authentication mechanism (e.g. the second authentication mechanism could have been an EAP-TTLS procedure). In the IMS registration the device includes the private user identifier that is linked to the certificate in the first authentication mechanism (e.g. that could have been EAP-TTLS operation) and a second public user identity. The S-CSCF in the IMS network performs a third party registration with the MCPTT AS which may include, but is not limited to, the IMS private user identifier, a second public user identifier for IMS and a device identifier.

At this point, there is now a linkage between the MCPTT AS and the IMS private user identifier, the second IMS public user identifier, the first public IMS user identifier and the device identifier.

Now when the MCPTT AS receives session requests, it has the option to hide the IMS second public user ID from the IMS network.

Reference is now made to FIG. **17**, which shows a UE **1710**, P-CSCF **1712**, a first public safety authority **1714** having a S-CSCF **1716** and an MCPTT AS **1718**.

The MCPTT AS **1718** includes a PS-UDF **1720** and an AAA **1722**.

A second public safety authority **1724** includes HSS **1726**.

In the embodiment of FIG. **17**, a second authentication mechanism **1730** occurs first, in which a registration between the UE and the second public safety authority happens. Registration includes the first private identity and a second public identity. In particular, as shown by block **1732** the registration includes the first private ID and second public user ID.

Based on the registration message of block **1732**, a third party registration **1734** may occur.

The UE will start the second authentication process using the first private user ID and second public user ID stored in the IMSI on the device. Upon completion of the process, the S-CSCF will do a third party registration with the MCPTT AS. In the third party registration the first private user ID and second public user ID are included. The MCPTT server will receive this information and then map the first private user ID with the second public user ID against data stored.

Upon successful second authentication, a first authentication mechanism **1740** starts. The first part of the first authentication mechanism **1740** is a tunnel setup **1742**. In the example of FIG. **17**, it is the MCPTT AS **1718** that has the authentication function and the tunnel setup with the MCPTT AS.

As shown by block **1744**, tunnel authentication next takes place. Certificates are exchanged between the UE and the network. The certificate is such that some or all of the following may be derived from it: the first private user ID on the (U)/ISIM; the second public user ID on the (U)/ISIM; and the IMEI or device identifier. During the tunnel setup authentication process, the MCPTT AS **1718** will create a database of the relationship between these items.

As shown by block **1746**, after successful creation of the tunnel another authentication process will be started to authenticate the public user ID that is using the device. For example, such ID may be police officer credentials. This will be called the first public user ID.

Upon successful authentication the MCPTT will associate this identifier with the information stored in the database described above, as shown by arrow **1750**.

Examples of certificates are provided below.

First Certificate Option

Reference is now made to FIG. **18** which shows a device detecting a new private identifier at block **1810** and generating a certificate at block **1812**. The generating certificate includes the device identifier **1814** and a private identifier **1816** as inputs to the generation block **1812**. Blocks **1810** and **1816** both contain the same Private User identity.

A certificate **1820** is provided as an output to generation block **1812**.

In one embodiment the device may or may not contain an initial certificate. Upon detection of a new UICC being inserted into the device or the detection that the IMSI or UICC code has changed, or a new USIM or ISIM is activated then the device will request a new certificate. The activation may, for example, be that the IMSI or IMS private user identity has changed.

The certificate that is created will identity the UICC/USIM/ISIM combination with the ME.

Second Certificate Option

In a second certificate option, a device ME_A is provisioned with a first certificate, where the first certificate contains a first public key that is used to verify signatures created by a first private key. The first private key is also provisioned to the ME_A.

USIM_A is inserted into the device with IMSI_A and a User_A logs into the device using UserIdA and pwdA.

Device ME_A signs [IMSI_A, pwdA, T_now] at time T_now to form the signature SigA.

Device sends CertA, SigA, [IMSI_A, UserIdA T_now] to the public safety operator who can now:

1) Identify ME_A from CertA
2) User_A from UserIdA and pwdA (assuming the public safety operator has its own copy of pwdA)
3) USIM_A from IMSI_A

All of these identities may be authenticated by verifying SigA where:

1) The signature SigA is computed using IMSI_A, UserIdA and KeyA, T_now.
2) The signature SigA is authenticated using SigA, IMSI_A, UserIdA, T_now and PubKeyA

The above therefore provides means to authenticate a user of a shared device without the need to change the UICC. The solutions provide various degrees of confidentiality of the user using the phone. The later out of band solutions provide means to hide a user, thus allowing the public safety operator to decide what information should be visible in the IMS network. They also provide various degrees of linkage between the IMS authentication mechanism and the user authentication mechanism.

The above creates a linkage so that the user, when authenticated on that device has to continue a session on that device unless they are authenticated again. The single logon does not allow a user to swap UICC SIM cards between devices for malicious purposes. Certificates on the device can be such that they can only be provisioned by the public safety operator, allowing only valid devices to be used on the network.

The servers and network elements in the embodiments of FIGS. **1** to **17** above can be any network element, or part of any network element, including various network servers. Reference is now made to FIG. **19**, which shows a generalized network element.

In FIG. **19**, network element **1910** includes a processor **1920** and a communications subsystem **1930**, where the processor **1920** and communications subsystem **1930** cooperate to perform the methods of the embodiments described above.

Processor **1920** is configured to execute programmable logic, which may be stored, along with data, on network element **1910**, and shown in the example of FIG. **19** as memory **1940**. Memory **1940** can be any tangible, non-transitory, storage medium.

Alternatively, or in addition to memory **1940**, network element **1910** may access data or programmable logic from an external storage medium, for example through communications subsystem **1930**.

Communications subsystem **1930** allows network element **1910** to communicate with other network elements. Examples of protocols for communication subsystem **1930** include cellular, Ethernet, WiFi, WiLAN, among others.

Communications between the various elements of network element **1910** may be through an internal bus **1950** in one embodiment. However, other forms of communication are possible.

Further, the above may be implemented by any UE. One exemplary device is described below with regard to FIG. **20**.

UE **2000** is typically a two-way wireless communication device having voice and data communication capabilities. UE **2000** generally has the capability to communicate with other computer systems on the Internet. Depending on the exact functionality provided, the UE may be referred to as a data messaging device, a two-way pager, a wireless e-mail device, a cellular telephone with data messaging capabilities, a wireless Internet appliance, a wireless device, a mobile device, or a data communication device, as examples.

Where UE **2000** is enabled for two-way communication, it may incorporate a communication subsystem **2011**, including both a receiver **2012** and a transmitter **2014**, as well as associated components such as one or more antenna elements **2016** and **2018**, local oscillators (LOs) **2013**, and a processing module such as a digital signal processor (DSP) **2020**. As will be apparent to those skilled in the field of communications, the particular design of the communication subsystem **2011** will be dependent upon the communication network in which the device is intended to operate.

Network access requirements will also vary depending upon the type of network **2019**. In some networks network access is associated with a subscriber or user of UE **2000**. A UE may require a removable user identity module (RUIM) or a subscriber identity module (SIM) card in order to operate on a CDMA network. The SIM/RUIM interface **2044** is normally similar to a card-slot into which a SIM/RUIM card can be inserted and ejected. The SIM/RUIM card can have memory and hold many key configurations **2051**, and other information **2053** such as identification, and subscriber related information.

When required network registration or activation procedures have been completed, UE **2000** may send and receive communication signals over the network **2019**. As illustrated in FIG. **20**, network **2019** can consist of multiple base stations communicating with the UE.

Signals received by antenna **2016** through communication network **2019** are input to receiver **2012**, which may perform such common receiver functions as signal amplification, frequency down conversion, filtering, channel selection and the like. A/D conversion of a received signal allows more complex communication functions such as demodulation and decoding to be performed in the DSP **2020**. In a similar manner, signals to be transmitted are processed, including modulation and encoding for example, by DSP **2020** and input to transmitter **2014** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission over the communication network **2019** via antenna

2018. DSP **2020** not only processes communication signals, but also provides for receiver and transmitter control. For example, the gains applied to communication signals in receiver **2012** and transmitter **2014** may be adaptively controlled through automatic gain control algorithms implemented in DSP **2020**.

UE **2000** generally includes a processor **2038** which controls the overall operation of the device. Communication functions, including data and voice communications, are performed through communication subsystem **2011**. Processor **2038** also interacts with further device subsystems such as the display **2022**, flash memory **2024**, random access memory (RAM) **2026**, auxiliary input/output (I/O) subsystems **2028**, serial port **2030**, one or more keyboards or keypads **2032**, speaker **2034**, microphone **2036**, other communication subsystem **2040** such as a short-range communications subsystem and any other device subsystems generally designated as **2042**. Serial port **2030** could include a USB port or other port known to those in the art.

Some of the subsystems shown in FIG. **20** perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as keyboard **2032** and display **2022**, for example, may be used for both communication-related functions, such as entering a text message for transmission over a communication network, and device-resident functions such as a calculator or task list.

Operating system software used by the processor **2038** may be stored in a persistent store such as flash memory **2024**, which may instead be a read-only memory (ROM) or similar storage element (not shown). Those skilled in the art will appreciate that the operating system, specific device applications, or parts thereof, may be temporarily loaded into a volatile memory such as RAM **2026**. Received communication signals may also be stored in RAM **2026**.

As shown, flash memory **2024** can be segregated into different areas for both computer programs **2058** and program data storage **2050**, **2052**, **2054** and **2056**. These different storage types indicate that each program can allocate a portion of flash memory **2024** for their own data storage requirements. Processor **2038**, in addition to its operating system functions, may enable execution of software applications on the UE. A predetermined set of applications that control basic operations, including at least data and voice communication applications for example, will normally be installed on UE **2000** during manufacturing. Other applications could be installed subsequently or dynamically.

Applications and software may be stored on any computer readable storage medium. The computer readable storage medium may be a tangible or in transitory/non-transitory medium such as optical (e.g., CD, DVD, etc.), magnetic (e.g., tape) or other memory known in the art.

One software application may be a personal information manager (PIM) application having the ability to organize and manage data items relating to the user of the UE such as, but not limited to, e-mail, calendar events, voice mails, appointments, and task items. Naturally, one or more memory stores would be available on the UE to facilitate storage of PIM data items. Such PIM application may have the ability to send and receive data items, via the wireless network **2019**. Further applications may also be loaded onto the UE **2000** through the network **2019**, an auxiliary I/O subsystem **2028**, serial port **2030**, short-range communications subsystem **2040** or any other suitable subsystem **2042**, and installed by a user in the RAM **2026** or a non-volatile store (not shown) for execution by the processor **2038**. Such flexibility in application installation increases the functionality of the device and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using the UE **2000**.

In a data communication mode, a received signal such as a text message or web page download will be processed by the communication subsystem **2011** and input to the processor **2038**, which may further process the received signal for output to the display **2022**, or alternatively to an auxiliary I/O device **2028**.

A user of UE **2000** may also compose data items such as email messages for example, using the keyboard **2032**, which may be a complete alphanumeric keyboard or telephone-type keypad, among others, in conjunction with the display **2022** and possibly an auxiliary I/O device **2028**. Such composed items may then be transmitted over a communication network through the communication subsystem **2011**.

For voice communications, overall operation of UE **2000** is similar, except that received signals would typically be output to a speaker **2034** and signals for transmission would be generated by a microphone **2036**. Alternative voice or audio I/O subsystems, such as a voice message recording subsystem, may also be implemented on UE **2000**. Although voice or audio signal output is generally accomplished primarily through the speaker **2034**, display **2022** may also be used to provide an indication of the identity of a calling party, the duration of a voice call, or other voice call related information for example.

Serial port **2030** in FIG. **20** would normally be implemented in a personal digital assistant (PDA)-type UE for which synchronization with a user's desktop computer (not shown) may be desirable, but is an optional device component. Such a port **2030** would enable a user to set preferences through an external device or software application and would extend the capabilities of UE **2000** by providing for information or software downloads to UE **2000** other than through a wireless communication network. The alternate download path may for example be used to load an encryption key onto the device through a direct and thus reliable and trusted connection to thereby enable secure device communication. As will be appreciated by those skilled in the art, serial port **2030** can further be used to connect the UE to a computer to act as a modem.

Other communications subsystems **2040**, such as a short-range communications subsystem, is a further optional component which may provide for communication between UE **2000** and different systems or devices, which need not necessarily be similar devices. For example, the subsystem **2040** may include an infrared device and associated circuits and components or a Bluetooth™ communication module to provide for communication with similarly enabled systems and devices. Subsystem **2040** may further include non-cellular communications such as WiFi or WiMAX.

The embodiments described herein are examples of structures, systems or methods having elements corresponding to elements of the techniques of this application. This written description may enable those skilled in the art to make and use embodiments having alternative elements that likewise correspond to the elements of the techniques of this application. The intended scope of the techniques of this application thus includes other structures, systems or methods that do not differ from the techniques of this application as described herein, and further includes other structures, systems or methods with insubstantial differences from the techniques of this application as described herein.

APPENDIX A

On sending an unprotected REGISTER request, the UE shall populate the header fields as follows:

a) a From header field set to the SIP URI that contains:

   1) if the UE supports RFC 6140 [191] and performs the functions of an external attached network, the main URI of the UE; else

   2) the public user identity to be registered;

b) a To header field set to the SIP URI that contains:

   1) if the UE supports RFC 6140 [191] and performs the functions of an external attached network, the main URI of the UE; else

   2) the public user identity to be registered;

c) a Contact header field set to include SIP URI(s) containing the IP address or FQDN of the UE in the hostport parameter. If the UE:

   1) supports GRUU (see table A.4, item A.4/53);

   2) supports multiple registrations;

   3) has an IMEI available; or

   4) has an MEID available;

   the UE shall include a "+sip.instance" header field parameter containing the instance ID. Only the IMEI shall be used for generating an instance ID for a multi-mode UE that supports both 3GPP and 3GPP2 defined radio access networks.

NOTE 2: The requirement placed on the UE to include an instance ID based on the IMEI or the MEID when the UE does not support GRUU and does not support multiple registrations does not imply any additional requirements on the network.

   If the UE supports multiple registrations it shall include "reg-id" header field parameter as described in RFC 5626 [92]. The UE shall include all supported ICSI values (coded as specified in subclause 7.2A.8.2) in a g.3gpp.icsi-ref media feature tag as defined in subclause 7.9.2 and RFC 3840 [62] for the IMS communication services it intends to use, and IARI values (coded as specified in subclause 7.2A.9.2), for the IMS applications it intends to use in a g.3gpp.iari-ref media feature tag as defined in subclause 7.9.3 and RFC 3840 [62].

   If the UE supports MCPTT application it shall include the g.3gpp.icsi-ref-mcptt feature tag.

   if the UE supports RFC 6140 [191] and performs The functions of an external attached network, for the registration of bulk number contacts the UE shall shall include a Contact URI without a user portion and containing the "bnc" URI parameter;

   If the UE supports MCPTT application it shall include a Contact URI and containing the " doubleauthentication " URI parameter.

d) a Via header field set to include the sent-by field containing the IP address or FQDN of the UE and the port number where the UE expects to receive the response to this request when UDPis used. For TCP, the response is received on the TCP connection on which the request was sent. For the UDP, the UE shall also include a "rport" header field parameter with no value in the Via header field. Unless the UE has been configured to not send keep-alives, and unless the UE is directly connected to an IP-CAN for which usage of NAT is not defined, it shall include a "keep" header field parameter with no value in the Via header field, in order to indicate support of sending keep-alives associated with the registration, as described in RFC 6223 [143];

NOTE 3: When sending the unprotected REGISTER request using UDP, the UE transmit the request from the same IP address and port on which it expects to receive the response to this request.

e) a registration expiration interval value of 600 000 seconds as the value desired for the duration of the registration;

NOTE 4: The registrar (S-CSCF) might decrease the duration of the registration in accordance with network policy. Registration attempts with a registration period of less than a predefined minimum value defined in the registrar will be rejected with a 423 (Interval Too Brief) response.

f) a Request-URI set to the SIP URI of the domain name of the home network used to address the REGISTER request;

g) the Supported header field containing the option-tag "path", and

1) if GRUU is supported, the option-tag "gruu"; ~~and~~

2) if multiple registrations is supported, the option-tag "outbound";

3) if MCPTT application is supported, the option-tag "double authentication"

5.1.1.2.2 Initial registration using IMS AKA

On sending a REGISTER request, as defined in subclause 5.1.1.2.1, the UE shall additionally populate the header fields as follows:

a) an Authorization header field, with:

- the "username" header field parameter, set to the value of the private user identity;
- the "realm" header field parameter, set to the domain name of the home network;
- the "uri" header field parameter, set to the SIP URI of the domain name of the home network;
- the "nonce" header field parameter, set to an empty value; and
- the "response" header field parameter, set to an empty value;

NOTE 1: If the UE specifies its FQDN in the hostport parameter in the Contact header field and in the sent-by field in the Via header field, then it has to ensure that the given FQDN will resolve (e.g., by reverse DNS lookup) to the IP address that is bound to the security association.

NOTE 2: The UE associates two ports, a protected client port and a protected server port, with each pair of security association. For details on the selection of the port values see 3GPP TS 33.203 [19].

b) additionally for the Contact header field, if the REGISTER request is protected by a security association, include the protected server port value in the hostport parameter;

c) additionally for the Via header field, for UDP, if the REGISTER request is protected by a security association, include the protected server port value in the sent-by field; and

d) a Security-Client header field set to specify the signalling plane security mechanism the UE supports, the IPsec layer algorithms the UE supports and the parameters needed for the security association setup. The UE shall support the setup of two pairs of security associations as defined in 3GPP TS 33.203 [19]. The syntax of the parameters needed for the security association setup is specified in annex H of 3GPP TS 33.203 [19]. **If the UE supports the MCPPT application then the UE shall support the "ipsec-MCPTT" security mechanism otherwise** the UE shall support the "ipsec-3gpp" securitylhanism, as specified in RFC 3329 [48]. The UE shall support the IPsec layer algorithms for integrity and confidentiality protection as defined in 3GPP TS 33.203 [19], and shall announce support for them according to the procedures defined in RFC 3329 [48].

Possible change to 3GPP TS 24.229

APPENDIX B

Table 6.3.2: Authentication Data content – Request

Information element name	**Mapping to Diameter AVP**	**Cat.**	**Description**
Authentication Scheme (See 7.9.2)	SIP-Authentication-Scheme	M	This information element indicates the authentication scheme. It shall contain: - "Digest-AKAv1-MD5" if the S-CSCF knows that IMS-AKA is to be used. - "**biometric finger prnt " if the S-CSCF knows that biometric finger prnt is to be used and 2 sets of authentications vectors are required**. - "Digest-AKAv2-SHA-256" if the S-CSCF knows that IMS-AKA using HTTP Digest AKAv2 is to be used. - "**Digest-AKAv2-SHA-256" if the S-CSCF knows that IMS-AKA using HTTP Digest AKAv2 is to be used and 2 sets of authentications vectors are required**. - "SIP Digest" if the S-CSCF knows that SIP Digest is to be used. - "NASS-Bundled" if the S-CSCF knows that NASS Bundled authentication is to be used. - "Early-IMS-Security" if the S-CSCF knows that GPRS-IMS-Bundled Authentication is to be used. - "Unknown" if the S-CSCF can not know the authentication scheme at this point.

Possible change to 3GPP 29.228

APPENDIX C

Table 6.3.2: Authentication Data content – Request

Information element name	Mapping to Diameter AVP	Cat.	Description
Authentication Scheme (See 7.9.2)	MCPTT SIP-Authentication-Scheme	O	This information element indicates the MCPTT authentication scheme. It shall contain: - " biometric finger prnt " if the S-CSCF knows that biometric finger prnt is to be used.- "Digest-AKAv2-SHA-256" if the S-CSCF knows that IMS-AKA using HTTP Digest AKAv2 is to be used. - "SIP Digest" if the S-CSCF knows that SIP Digest is to be used. - "NASS-Bundled" if the S-CSCF knows that NASS Bundled authentication is to be used. - "Early-IMS-Security" if the S-CSCF knows that GPRS-IMS-Bundled Authentication is to be used. - "biometric finger prnt" if the S-CSCF knows biometric finger print is being used. - "Unknown" if the S-CSCF can not know the authentication scheme at this point.

Possible change to 3GPP 29.228

APPENDIX D

Table 6.3.5.bis: Authentication Data content – Response for IMS-AKA

Information element name	**Mapping to Diameter AVP**	**Cat.**	**Description**
Item Number (See 7.9.1)	SIP-Item-Number	C	This information element shall be present in a SIP-Auth-Data-Item grouped AVP in circumstances where there are multiple occurrences of SIP-Auth-Data-Item AVPs, and the order in which they should be processed is significant. In this scenario, SIP-Auth-Data-Item AVPs with a low SIP-Item-Number value should be processed before SIP-Auth-Data-Items AVPs with a high SIP-Item-Number value.
Authentication Scheme (See 7.9.2)	SIP-Authentication-Scheme	M	Authentication scheme. It shall contain " **biometric finger prnt** " or "**D**Digest-AKAv2-SHA-256" for IMS-AKA using HTTp Digest AKAv2.
Authentication Information (See 7.9.3)	SIP-Authenticate	M	It shall contain, binary encoded, the concatenation of the authentication challenge RAND and the token AUTN. See 3GPP TS 33.203 [3] for further details about RAND and AUTN. The Authentication Information has a fixed length of 32 octets; the 16 most significant octets shall contain the RAND, the 16 least significant octets shall contain the AUTN.
Authorization Information (See 7.9.4)	SIP-Authorization	M	It shall contain, binary encoded, the expected response XRES. See 3GPP TS 33.203 [3] for further details about XRES.
Confidentiality Key (See 7.9.5)	Confidentiality-Key	O	This information element, if present, shall contain the confidentiality key. It shall be binary encoded.
Integrity Key (See 7.9.6)	Integrity-Key	M	This information element shall contain the integrity key. It shall be binary encoded.

Possible change to 3GPP 29.228

APPENDIX E

5.1.1.5 Authentication
5.1.1.5.1 IMS AKA - general
Authentication is performed during initial registration. A UE can be re-authenticated during subsequent reregistrations, deregistrations or registrations of additional public user identities. When the network requires authentication or re-authentication of the UE, the UE will receive a 401 (Unauthorized) response to the REGISTER request.
On receiving a 401 (Unauthorized) response to the REGISTER request, the UE shall:

1) extract the RAND and AUTN parameters;

2) check the validity of a received authentication challenge, as described in 3GPP TS 33.203 [19] i.e. the locally calculated XMAC must match the MAC parameter derived from the AUTN part of the challenge; and the SQN parameter derived from the AUTN part of the challenge must be within the correct range; and

3) check the existence of the Security-Server header field as described in RFC 3329 [48]. If the Security-Server header field is not present or it does not contain the parameters required for the setup of the set of security associations (see annex H of 3GPP TS 33.203 [19]), the UE shall abandon the authentication procedure and send a new REGISTER request with a new Call-ID.

In the case that the 401 (Unauthorized) response to the REGISTER request is deemed to be valid the UE shall:

If the UE supports the MCPTT application, the UE requested double authentication (see step 1 above) and the 401 (Unauthorized) response to the REGISTER request contains a second instance of the WWW-Authenticate header, then the UE shall:

1) extract the CHALLENGE and AUTHN parameters;

2) check the validity of a received authentication challenge by using the AUTHN parameter; and

In the case that the AUTHN parameter is deemed to be valid the UE shall:

1) execute the MCPTT application authentication as described in 3GPP TS 33.xxx [19];

1) calculate the RES parameter and derive the keys CK and IK from RAND as described in

Possible change to 3GPP TS 24.229

APPENDIX F

5.1.1.4.2 IMS AKA as a security mechanism

On sending a REGISTER request, as defined in subclause 5.1.1.4.1, the UE shall additionally populate the header fields as follows:

a) an Authorization header field, with:

- the "username" header field parameter set to the value of the private user identity;
- the "realm" header field parameter directive, set to the value as received in the "realm" WWW-Authenticate header field parameter;
- the "uri" header field parameter, set to the SIP URI of the domain name of the home network;
- the "nonce" header field parameter, set to last received nonce value; and
- the "response" header field parameter, set to the last calculated response value **with the second calculated response appended to the 1st using "|".**

Possible change to 3GPP TS 24.229

APPENDIX G

Table 6.3.2: Authentication Data content – Request

Information element name	Mapping to Diameter AVP	Cat.	Description
Authentication Scheme (See 7.9.2)	SIP-Authentication-Scheme	M	This information element indicates the authentication scheme. It shall contain: - "Digest-AKAv1-MD5" if the S-CSCF knows that IMS-AKA is to be used. - "Digest-AKAv2-SHA-256" if the S-CSCF knows that IMS-AKA using HTTP Digest AKAv2 is to be used. - "SIP Digest" if the S-CSCF knows that SIP Digest is to be used. - "NASS-Bundled" if the S-CSCF knows that NASS Bundled authentication is to be used. - "Early-IMS-Security" if the S-CSCF knows that GPRS-IMS-Bundled Authentication is to be used. - "Unknown" if the S-CSCF can not know the authentication scheme at this point. **- "Public-User-Authentication" if the S-CSCF knows that Public User Identity is to be authenticated**.
Authentication Context (See 7.9.7)	SIP-Authentication-Context	C	It shall contain authentication-related information relevant for performing the authentication. When Authentication Scheme contains "Digest-AKAv1-MD5" "**Public-User-Authentication"** or "Digest-AKAv2-SHA-256", this AVP is not used and shall be missing.

Possible change to 3GPP 29.228

APPENDIX H

Table 6.3.1: Authentication Request

Information element name	Mapping to Diameter AVP	Cat.	Description
Public User Identity (See 7.2)	Public-Identity	M	This information element contains the Distinct Public User Identity of the user
Private User Identity (See 7.3)	User-Name	M	This information element contains the Private User Identity
Number Authentication Items (See 7.10)	SIP-Number-Auth-Items	M	This information element indicates the number of authentication vectors requested. Certain authentication schemes do not support more than one set of authentication vectors (e.g. SIP Digest, GIBA).
Authentication Data (See 7.9)	SIP-Auth-Data-Item	M	See Tables 6.3.2 and 6.3.3 for the contents of this information element. The content shown in table 6.3.2 shall be used for a normal authentication request; the content shown in table 6.3.3 shall only be used for an IMS-AKA authentication request after synchronization failure.
S-CSCF Name (See 7.4)	Server-Name	M	This information element contains the name (SIP URL) of the S-CSCF.
Routing Information (See 7.13)	Destination-Host	C	If the S-CSCF knows the HSS name this AVP shall be present. This information is available if the MAR belongs to an already existing registration, e.g. in case of the re-registration, where the HSS name is stored in the S-CSCF. The HSS name is obtained from the Origin-Host AVP, which is received from the HSS, e.g. included in the MAA command. This information may not be available if the command is sent in case of the initial registration. In this case the Destination-Host AVP is not present and the command is routed to the next Diameter node, e.g. SLF, based on the Diameter routing table in the client.

3GPP 29.228 Authentication Request Data

APPENDIX I

Table 6.3.5.bis: Authentication Data content – Response for IMS-AKA

Information element name	Mapping to Diameter AVP	Cat.	Description
Item Number (See 7.9.1)	SIP-Item-Number	C	This information element shall be present in a SIP-Auth-Data-Item grouped AVP in circumstances where there are multiple occurrences of SIP-Auth-Data-Item AVPs, and the order in which they should be processed is significant. In this scenario, SIP-Auth-Data-Item AVPs with a low SIP-Item-Number value should be processed before SIP-Auth-Data-Items AVPs with a high SIP-Item-Number value.
Authentication Scheme (See 7.9.2)	SIP-Authentication-Scheme	M	Authentication scheme. It shall contain "DDigest-AKAv1-MD5" or "DDigest-AKAv2-SHA-256" for IMS-AKA using HTTP Digest AKAv2. **- "Public-User-Authentication" if the S-CSCF knows that Public User Identity is to be authenticated.**
Authentication Information (See 7.9.3)	SIP-Authenticate	M	It shall contain, binary encoded, the concatenation of the authentication challenge RAND and the token AUTN. See 3GPP TS 33.203 [3] for further details about RAND and AUTN. The Authentication Information has a fixed length of 32 octets; the 16 most significant octets shall contain the RAND, the 16 least significant octets shall contain the AUTN. **If "Public-User-Authentication" is included this field is blank** **ALTERNATIVE IMPLEMENTATION** **This field contains the challenge to be sent to the device.**
Authorization Information (See 7.9.4)	SIP-Authorization	M	It shall contain, binary encoded, the expected response XRES. See 3GPP TS 33.203 [3] for further details about XRES.
Confidentiality Key (See 7.9.5)	Confidentiality-Key	O	This information element, if present, shall contain the confidentiality key. It shall be binary encoded.
Integrity Key (See 7.9.6)	Integrity-Key	M	This information element shall contain the integrity key. It shall be binary encoded.

Possible change to 3GPP 29.228

APPENDIX J

6.3.15 Server-Assignment-Type AVP

The Server-Assignment-Type AVP is of type Enumerated, and indicates the type of server update, request or notification being performed in a Server-Assignment-Request operation. The following values are defined:

NO_ASSIGNMENT (0)

This value is used to request from HSS the user profile assigned to one or more public identities and to retrieve the S-CSCF restoration information for a registered Public User Identity, without affecting the registration state of those identities.

REGISTRATION (1)

The request is generated as a consequence of a first registration of an identity.

....

RESTORATION (14)

Used in the SWx protocol, defined in 3GPP TS 29.273 [18]. This value is not used in the Cx protocol.

MCPTT REGISTRATION (14)

The request is generated as a consequence of a registration of an identity for MCPTT service.

Possible Changes to 3GPP 29.229

APPENDIX K

6.1.3Server-Assignment-Request (SAR) Command

The Server-Assignment-Request (SAR) command, indicated by the Command-Code field set to 301 and the 'R' bit set in the Command Flags field, is sent by a Diameter Multimedia client to a Diameter Multimedia server in order to request it to store the name of the server that is currently serving the user.

Message Format

<Server-Assignment-Request> ::= < Diameter Header: 301, REQ, PXY, 16777216 >
< Session-Id >
{ Vendor-Specific-Application-Id }
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
[Destination-Host]
{ Destination-Realm }
[User-Name]
[OC-Supported-Features]
***[Supported-Features]**
***[Public-Identity]**
[Wildcarded-Public-Identity]
{ Server-Name }
{ Server-Assignment-Type }
{ User-Data-Already-Available }
[SCSCF-Restoration-Info]
[Multiple-Registration-Indication]
[Session-Priority]
[Application-Registration]
*[AVP]
*[Proxy-Info]
*[Route-Record]

6.3.X Application-Registration AVP

The Applications-Registration AVP is of type Grouped and it contains the application that the user is registering for.

AVP format

Supported-Applications ::= < AVP header: 12345678 >
***[Application]**

Application is of OctectString or UTF*String and contains the name of the application being registered for. Valid entries are:
"MCPTT"

Possible Changes to 3GPP 29.229

APPENDIX L

5.1.1.5 Authentication

5.1.1.5.1 IMS AKA - general

Authentication is performed during initial registration. A UE can be re-authenticated during subsequent reregistrations, deregistrations or registrations of additional public user identities. When the network requires authentication or re-authentication of the UE, the UE will receive a 401 (Unauthorized) response to the REGISTER request.

……

4) send another REGISTER request towards the protected server port indicated in the response using the temporary set of security associations to protect the message. The header fields are populated as defined for the initial REGISTER request that was challenged with the received 401 (Unauthorized) response, with the addition that the UE shall include an Authorization header field containing:

If UE does not wants to perform Public User Identity authentication for a specific application then:

- the "realm" header field parameter set to the value as received in the "realm" WWW-Authenticate header field parameter;
- the "username" header field parameter, set to the value of the private user identity
- the "response" header field parameter that contains the RES parameter, as described in RFC 3310 [49]
- the "uri" header field parameter, set to the SIP URI of the domain name of the home network;
- the "algorithm" header field parameter, set to the value received in the 401 (Unauthorized) response; and
- the "nonce" header field parameter, set to the value received in the 401 (Unauthorized) response.

If UE does wants to perform Public User Identity authentication for a specific application then:

- **the "realm" header field parameter set to the value as received in the "realm" WWW-Authenticate header field parameter;**

THEN

- **the "username" header field parameter, set to the value of the private user identity, and if MCPTT application is supported appended the Public User Identity to be used for MCPTT application as defined in 3GPP TS 23.003 [yy].**

OR ALTERNATIVE

- **the "username" header field parameter, set to the value of the Public User Identity to be authenticated;**

FOLLOWING IS COMMON

- **the "response" header field parameter that contains the RES parameter, for the Public User Identity to be used for MCPTT application**
- **the "uri" header field parameter, set to the SIP URI of the domain name of the home network;**
- **the "algorithm" header field parameter, set to the value "public user authentication"; and**
- **the "nonce" header field parameter, set to the value "public user authentication".**

The UE shall also insert the Security-Client header field that is identical to the Security-Client header field that was included in the previous REGISTER request (i.e. the REGISTER request that was challenged with the received 401 (Unauthorized) response). The UE shall also insert the Security-Verify header field into the request, by mirroring in it the content of the Security-Server header field received in the 401 (Unauthorized) response. The UE shall set the Call-ID of the security association protected REGISTER request which carries the authentication challenge response to the same value as the Call-ID of the 401 (Unauthorized) response which carried the challenge.

Possible Changes to 3GPP 29.229

APPENDIX M

7.1.2 Command parameters and data

……

Code	Value
CLA	As specified in TS 31.101 [11]
INS	'88'
P1	'00'
P2	See table 1 below
Lc	See below
Data	See below
Le	'00', or maximum length of data expected in response

Parameter P2 specifies the authentication context as follows:

Table 1: Coding of the reference control P2

Coding b8-b1	Meaning
'1-------'	Specific reference data (e.g. DF specific/application dependant key)
'----- XXX'	Authentication context: 000 Reserved 001 IMS AKA 010 HTTP Digest **101 external authentication**

All other codings are RFU.

…..

7.1.2.1a external extension

Byte(s)	**Description**	**Length**
1	**Length of RAND (L1)**	**1**
2 to (L1+1)	**RAND**	**L1**
(L1+2)	**Length of AUTN (L2) (see note)**	**1**
(L1+3) to (L1+L2+2)	**AUTN (see note)**	**L2**
L1+L2+3) to (L1+L2+L3+2)	**External authentication input key**	**L3**
Note: Parameter present if and only if in 3G security context.		

The coding of AUTN is described in TS 33.102 [13]. The most significant bit of RAND is coded on bit 8 of byte 2. The most significant bit of AUTN is coded on bit 8 of byte (L1+3).

The external authentication input key is of variable length of alphanumeric digits. It consists of a tag , length and content.

Response parameters/data, case 1, 3G security context, command successful:

Byte(s)	Description	Length
1	"Successful 3G authentication" tag = 'DB'	1
2	Length of RES (L3)	1
3 to (L3+2)	RES	L3
(L3+3)	Length of CK (L4)	1
(L3+4) to (L3+L4+3)	CK	L4
(L3+L4+4)	Length of IK (L5)	1
(L3+L4+5) to (L3+L4+L5+4)	IK	L5
(L3+L4+L5+5)	Length of K_C (= 8) (see note)	1
(L3+L4+L5+6 to (L3+L4+L5+13)	K_C (see note)	8
Note: Parameter present if and only if Service n°27 is "available".		

The most significant bit of RES is coded on bit 8 of byte 3. The most significant bit of CK is coded on bit 8 of byte (L3+4). The most significant bit of IK is coded on bit 8 of byte (L3+L4+5).
Response parameters/data, case 2, 3G security context, synchronisation failure:

Byte(s)	Description	Length
1	"Synchronisation failure" tag = 'DC'	1
2	Length of AUTS (L1)	1
3 to (L1+2)	AUTS	L1

The coding of AUTS is described in TS 33.102 [13]. The most significant bit of AUTS is coded on bit 8 of byte 3.
Response parameters/data, case 3, GSM security context, command successful:

Byte(s)	Description	Length
1	Length of SRES (= 4)	1
2 to 5	SRES	4
6	Length of K_C (= 8)	1
7 to 14	K_C	8

The most significant bit of SRES is coded on bit 8 of byte 2. The most significant bit of Kc is coded on bit 8 of byte 7.

Possible Changes to 3GPP TS 31.103

APPENDIX N

Table 6.3.1: Authentication Request

Information element name	Mapping to Diameter AVP	Cat.	Description
Public User Identity (See 7.2)	Public-Identity	M	This information element contains the Distinct Public User Identity of the user
Private User Identity (See 7.3)	User-Name	M	This information element contains the Private User Identity
Number Authentication Items (See 7.10)	SIP-Number-Auth-Items	M	This information element indicates the number of authentication vectors requested. Certain authentication schemes do not support more than one set of authentication vectors (e.g. SIP Digest, GIBA).
Authentication Data (See 7.9)	SIP-Auth-Data-Item	M	See Tables 6.3.2 and 6.3.3 for the contents of this information element. The content shown in table 6.3.2 shall be used for a normal authentication request; the content shown in table 6.3.3 shall only be used for an IMS-AKA authentication request after synchronization failure.
S-CSCF Name (See 7.4)	Server-Name	M	This information element contains the name (SIP URL) of the S-CSCF.
Routing Information (See 7.13)	Destination-Host	C	If the S-CSCF knows the HSS name this AVP shall be present. This information is available if the MAR belongs to an already existing registration, e.g. in case of the re-registration, where the HSS name is stored in the S-CSCF. The HSS name is obtained from the Origin-Host AVP, which is received from the HSS, e.g. included in the MAA command. This information may not be available if the command is sent in case of the initial registration. In this case the Destination-Host AVP is not present and the command is routed to the next Diameter node, e.g. SLF, based on the Diameter routing table in the client.

Authentication Function

APPENDIX O

8.2.XIdentity attributes

8.2.X.1 AT_Identity_Request attribute

7	6	5	4	3	2	1	0	
Attribute Type = AT_Identity_Request								octet 1
Length = 1								octet 2
Value								octet 3 octet 4

Figure 8.2.X.1-1: AT_Identity_Request attribute

Table 8.2.X.1-1: : AT_Identity_Request attribute

Octet 1 indicates the type of attribute as AT_Identity_Request with a value of 1XX.

Octet 2 is the length of this attribute which shall be set to 1 as per IETF RFC 4187 [33]

Octet 3 and 4 is the value of the attribute. Octet 3 is reserved and shall be coded as zero. Octet 4 shall be set as follows. All other values are reserved.

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	Identity request
0	0	0	0	0	0	0	1	Public User Identity
0	0	0	0	0	0	1	0	Private User Identity
0	0	0	0	0	0	1	1	Private and Public User Identity

Possible changes to 3GPP TS 24.302

APPENDIX P

8.2.X.2 AT_Identity_Request_RESP attribute

8.2.X.2.1 General

7 6 5 4 3 2 1 0	
Attribute Type = AT_Identity_Request_RESP	octet 1
Length = 1	octet 2
Value	octet 3 octet Z

Figure 8.2.X.1-1: AT_Identity_Request attribute_RESP

8.2.x.2.2 Value

There may be multiple Values encoded in the AT_Identity_Request_RESP.

7 6 5 4 3 2 1 0	
Value	octet 1
Length = 1	octet 2
Identity	octet 3 octet Z

Figure 8.2.X.1-1: AT_Identity_Request attribute_RESP Value

Table 8.2.X.1-1: : AT_Identity_Request attribute_RESP Value

Octet 1 indicates the identity that is encoded. .

Octet 1 shall be set as follows. All other values are reserved.

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	Identity Encoded
0	0	0	0	0	0	0	1	Public User Identity
0	0	0	0	0	0	1	0	Private User Identity
0	0	0	0	0	0	1	1	Private and Public User Identity

8.2.x.2.3 Identity

The identity field is an octet string encoded according to UTF-8 encoding rules as specified in IETF RFC 3629 [34].

Possible changes to 3GPP TS 24.302

APPENDIX Q

6.1.2Data Update (Sh-Update)

This procedure is used between the AS and the HSS. The procedure is invoked by the AS and is used:

- To allow the AS to update the transparent (repository) data stored at the HSS for each IMS Public User Identity (for Public User Identities matching a Wildcarded Public User Identity, the transparent data shall be stored per Wildcarded Public User Identity, and not for each specific Public User Identity matching that Wildcarded Public User Identity) or Public Service Identity (for Public Service Identities matching a Wildcarded PSI, the transparent data shall be stored per Wildcarded PSI, and not for each specific Public Service Identity matching that Wildcarded PSI).
- To allow the AS to update the PSI Activation State of a distinct Public Service Identity in the HSS.
- To allow the AS to update the Dynamic Service Activation Info stored at the HSS.
- To allow the AS to update the Short Message Service Registration Info stored at the HSS.
- **To allow the AS to update a service repository function (e.g. PS-UDF) with identities that have registered for that service.**

This procedure is mapped to the commands Profile-Update-Request/Answer in the Diameter application specified in 3GPP TS 29.329 [5]. Tables 6.1.2.1 and 6.1.2.2 detail the involved information elements.

7.6.3IMS User State

This information element contains the IMS User State of the public identifier referenced. Its possible values are:

- REGISTERED,
- NOT_REGISTERED,
- AUTHENTICATION_PENDING,
- REGISTERED_UNREG_SERVICES.
- **REGISTERED for service X,**
- **NOT_REGISTERED for service X,**

If the IMS Public User Identity is shared between multiple Private User Identities, HSS shall indicate the most registered state of the shared IMS Public User Identity to an AS. The most registered state of a shared IMS Public User Identity is defined as follows:

- If the shared IMS Public User Identity is registered with any of the Private User Identities, the most registered state of the shared IMS Public User Identity is REGISTERED.
- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, but it is in state REGISTERED_UNREG_SERVICES,

then the most registered state of the shared IMS Public User Identity is REGISTERED_UNREG_SERVICES.

- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, but it is in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is AUTHENTICATION_PENDING.
- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, and it is not in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is NOT_REGISTERED.

NOTE X ABOVE IS REPLACED WITH MCPTT

7.6.X Service Registered for

This information element contains the ID of the Service that the IMS User has registered for. Its possible values are:

- **MCPTT (0)**
- **PTT (1)**

7.6.X+1 Device ID

This information element contains the Device ID of the device that the IMS User has registered for MCPTT services. Its possible values are:

- **Instance-ID (see 3GPP TS 24.229)**

Possible changes to 3GPP TS 29.328

APPENDIX R

Table 6.1.4.1: Sh-Notify

Information element name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 7.1)	User-Identity	M	IMS Public User Identity or Public Service Identity or MSISDN for which data has changed. If the request refers to a Wildcarded PSI, the HSS may include any PSI matching the corresponding Wildcarded PSI in this information element. The AS shall find the corresponding Wildcarded PSI with this information. See section 7.1 for the content of this AVP.
Wildcarded PSI (See 7.1A)	Wildcarded-Public-Identity	O	If the request refers to a Wildcarded PSI, the HSS shall include the corresponding Wildcarded PSI in this information element. If this element is present, it shall be used by the AS instead of the User Identity to identify the identity affected by the request.
Wildcarded Public User Identity (See 7.1B)	Wildcarded-IMPU	O	If the request refers to a Wildcarded Public User Identity, the HSS shall include the corresponding Wildcarded Public User Identity in this information element. If this element is present, it shall be used by the AS instead of the User Identity to identify the identity affected by the request.
Data (See 7.6)	User-Data	M	Changed data.
Private Identity (see 7.6.19)	User-Name	C	Private Identity of the user for whom the data is required. This information element shall be present only if the associated request included the Private Identity.

7.6.3 IMS User State

This information element contains the IMS User State of the public identifier referenced. Its possible values are:

- REGISTERED,

- NOT_REGISTERED,
- AUTHENTICATION_PENDING,
- REGISTERED_UNREG_SERVICES.
- **REGISTERED for service X,**
- **NOT_REGISTERED for service X,**

If the IMS Public User Identity is shared between multiple Private User Identities, HSS shall indicate the most registered state of the shared IMS Public User Identity to an AS. The most registered state of a shared IMS Public User Identity is defined as follows:

- If the shared IMS Public User Identity is registered with any of the Private User Identities, the most registered state of the shared IMS Public User Identity is REGISTERED.
- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, but it is in state REGISTERED_UNREG_SERVICES, then the most registered state of the shared IMS Public User Identity is REGISTERED_UNREG_SERVICES.
- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, but it is in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is AUTHENTICATION_PENDING.
- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, and it is not in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is NOT_REGISTERED.

7.6.X Service Registered for
This information element contains the ID of the Service that the IMS User has registered for. Its possible values are:

- **MCPTT (0)**
- **PTT (1)**
-

7.6.X+1 Device ID
This information element contains the Device ID of the device that the IMS User has registered for MCPTT services. Its possible values are:

- **Instance-ID (see 3GPP TS 24.229)**

Possible Changes to 3GPP 29.328.

APPENDIX S

8.2.X Identity attributes

8.2.X.1 AT_Identity_Request attribute

7	6	5	4	3	2	1	0	
Attribute Type = AT_Identity_Request								octet 1
Length = 1								octet 2
Value								octet 3 octet 4

Figure 8.2.X.1-1: AT_Identity_Request attribute

Table 8.2.X.1-1: : AT_Identity_Request attribute

Octet 1 indicates the type of attribute as AT_Identity_Request with a value of 1XX.

Octet 2 is the length of this attribute which shall be set to 1 as per IETF RFC 4187 [33]

Octet 3 and 4 is the value of the attribute. Octet 3 is reserved and shall be coded as zero. Octet 4 shall be set as follows. All other values are reserved.

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	Identity request
0	0	0	0	0	0	0	1	ME identifier
0	0	0	0	0	0	1	0	PLMN registered on
0	0	0	0	0	0	1	1	ME identifier and PLMN registered on

Possible changes to 3GPP TS 24.302

APPENDIX T

8.2.X.2 AT_PLMN_ID_attribute_RESP

8.2.X.2.1 General

7	6	5	4	3	2	1	0	
Attribute Type = AT_Network_ID								octet 1
Length = 1								octet 2
PLMN List IE								octet 3 octet Z

Figure 8.2.X.1-1: AT_PLMN_ID attribute_RESP

8.2.X.2.2 PLMN List IE

The PLMN List information element is used by the network to determine the MCPTT server that should be selected. The format of the PLMN List information element coded according to 3GPP TS 24.007 [48] subclause 11.2.2.1 is shown in figure 8.2.X.2.2-1

7	6	5	4	3	2	1	0	
PLMN List IEI								octet 1
Length of PLMN List value contents								octet 2
Number of PLMNs								octet 3
PLMN information, PLMN 1								octet 4 octet 5 octet 6
PLMN information, PLMN N								octet 3N+1 octet 3N+2

Figure 8.2.X.2.1.2-1: *PLMN List* information element

The "Number of PLMNs" (octet 3) contains the number of PLMN information items in the list. Bit 7 of octet 3 is the most significant bit and bit 0 of octet 3 the least significant bit.
The format of the PLMN information item according to 3GPP TS 24.007 [48] subclause 11.2.2.1 is shown in figure 8.2.X.2.2-2:

7	6	5	4	3	2	1	0	
MCC digit 2				MCC digit 1				octet X
MNC digit 3				MCC digit 3				octet X+1
MNC digit 2				MNC digit 1				octet X+2

Figure 8.2.X.2.2-2: *PLMN information* item of the PLMN List IE

8.2.X.3 AT_ME_ID_attribute_RESP

8.2.X.3.1 General

7	6	5	4	3	2	1	0	
Attribute Type = AT_Network_ID								octet 1
Length = 1								octet 2
Mobile ID_IE								octet 3 octet Z

Figure 8.2.X.3-1: AT_ME_ID attribute_RESP

8.2.X.3.2 Mobile_ID_IE

8	7	6	5	4	3	2	1	
	Mobile ID IE							octet 1
Length of mobile identity contents								octet 2
Identity digit 1				odd/ even indic	Type of identity			octet 3
Identity digit p+1				Identity digit p				octet 4*

Figure 10.5.4/3GPP TS 24.008 *Mobile Identity* information element

Type of identity (octet 3)
Bits

3	**2**	**1**	
0	0	1	IMSI
0	1	0	IMEI
0	1	1	IMEISV
1	0	0	TMSI/P-TMSI/M-TMSI
1	0	1	TMGI and optional MBMS Session Identity
0	0	0	No Identity (note 1)

Possible changes to 3GPP TS 24.302 [16]

APPENDIX U

4.2.2 EFIMPIMCPTT (user identities_for_MCPTT)

This EF contains the private user identity of the user for accessing MCPTT based services.

Identifier: '6F02'	Structure: transparent	Mandatory
SFI: '02'		
File size: X bytes	Update activity: low	

Access Conditions:

READ	PIN
UPDATE	ADM
DEACTIVATE	ADM
ACTIVATE	ADM

Bytes	Description	M/O	Length
1 to X	NAI TLV data object (Private ID)	M	X bytes
	NAI TLV data object (Public ID)	O	
X+1 to X+3	1st PLMN (highest priority)	O	3 bytes
X+4 to X+5	1st PLMN Access Technology Identifier	O	2 bytes
X+6 to X+8	2nd PLMN	O	3 bytes
X+9 to X+10	2nd PLMN Access Technology Identifier	O	2 bytes
:	:		
36 to 38	8th PLMN	O	3 bytes
39 to 40	8th PLMN Access Technology Identifier	O	2 bytes

- NAI Private ID

  Contents:

  - Private user identity of the user.

  Coding:

  - For contents and syntax of NAI TLV data object values see IETF RFC 2486 [24]. The NAI shall be encoded to an octet string according to UTF-8 encoding rules as specified in IETF RFC 3629 [27]. The tag value of the NAI TLV data object shall be '80'.

- NAI Public ID

  Contents:

  - Private user identity of the user.

  Coding:

  - For contents and syntax of NAI TLV data object values see IETF RFC 2486 [24]. The NAI shall be encoded to an octet string according to UTF-8 encoding rules as specified in IETF RFC 3629 [27]. The tag value of the NAI

TLV data object shall be '80'.

- PLMN

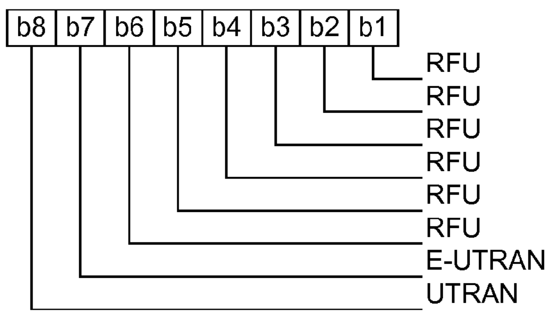
Contents:
- Mobile Country Code (MCC) followed by the Mobile Network Code (MNC).

Coding:
- according to TS 24.008 [9].

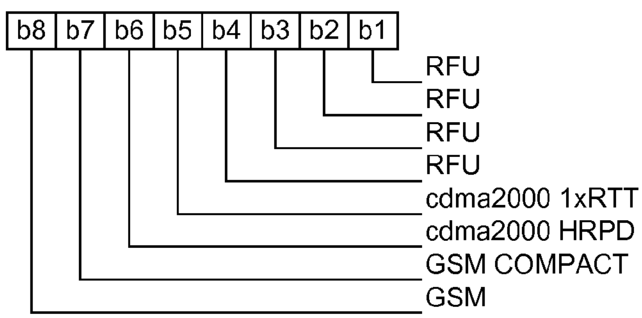
- Access Technology Identifier:

Coding:
- 2 bytes are used to select the access technology where the meaning of each bit is as follows:
  - bit = 1: access technology selected;
  - bit = 0: access technology not selected.

Byte5n-1:



Byte 5n:



Possible changes to 3GPP TS 31.103

APPENDIX V

8.6 Command details

Byte(s)	Description	Length
1	Command details tag	1
2	Length = '03'	1
3	Command number	1
4	Type of command	1
5	Command Qualifier	1

Command number:
- Contents and coding: see clause 6.5.1.

Type of command:
- Contents:
  - the Type of Command specifies the required interpretation of the data objects which follow, and the required terminal procedure;
- Coding:
  - see clause 9.4;
  - the terminal shall respond to reserved values (i.e. values not listed) with the result "Command type not understood".

Command Qualifier:
- Contents: qualifiers specific to the command;
- Coding:
  - REFRESH:
    - '00' = NAA Initialization and Full File Change Notification;
    - '01' = File Change Notification;
    - '02' = NAA Initialization and File Change Notification;
    - '03' = NAA Initialization;
    - '04' = UICC Reset;
    - '05' = NAA Application Reset, only applicable for a 3G platform;
    - '06' = NAA Session Reset, only applicable for a 3G platform;
    - '07' = Reserved by 3GPP ("Steering of Roaming" REFRESH support);
    - '08' = Reserved by 3GPP (Steering of Roaming for I-WLAN);
    - **'09' = Reserved by 3GPP (MCPTT Private User ID update);**
    - **'0A'** to 'FF' = reserved values.
  - MORE TIME: this byte is RFU.

Possible Changes to ETSI TS 102 223

The invention claimed is:

1. A method at a user equipment for registering with a third network node using an internet protocol (IP) multimedia subsystem (IMS), the method comprising:

creating a tunnel between the user equipment and a first network node;

authenticating a first public identity associated with the user equipment to the first network node;

receiving configuration information from the first network node with a second private user identifier and a second public user identifier, the second private user identifier and second public user identifier being associated with a second network node; and

registering with a third network node using the second private user identifier and the second public user identifier,

wherein the first network node is a first mission critical push to talk (MCPTT) server, the second network node is a second MCPTT server, and the third network node is a serving call session control function (S-CSCF).

2. The method of claim **1**, wherein a certificate is provided in the tunnel.

3. The method of claim **2**, wherein the certificate is created based on an identifier at the user equipment.

4. The method of claim **3**, wherein the identifier is one of a device identifier or a private user identifier.

5. The method of claim **4**, wherein the identifier is stored on a universal integrated circuit card on the user equipment.

6. The method of claim **4**, wherein the identifier is stored in a mobile equipment (ME) of the user equipment.

7. The method of claim **1**, wherein the creating uses a certificate requested by the user equipment.

8. The method of claim **1**, wherein the authenticating provides from the user equipment to the first network node at least one of a device identifier or a network the UE is registered on.

9. The method of claim **1**, wherein the receiving configuration information is subsequent to providing a configuration request to the first network node, including a network identifier that the user equipment is registered on.

10. The method of claim **1**, wherein the receiving configuration information comprises using preconfigured data stored on the user equipment.

11. The method of claim **10**, wherein the preconfigured data is divided into validity areas, wherein the user equipment uses the second private user identifier and second public user identifier based on the location of the user equipment.

12. The method of claim **11**, wherein the validity area is defined based on a network the user equipment is connected to or a geographic bounding area the user equipment falls within.

13. The method of claim **1**, wherein the registering includes receiving challenge vectors for the second private user identifier and second public user identifier.

14. A user equipment configured for registering with a third network node using an internet protocol (IP) multimedia subsystem (IMS), the user equipment comprising:

a processor; and

a communications subsystem,

wherein the user equipment is configured to:

create a tunnel between the user equipment and a first network node;

authenticate a first public identity associated with the user equipment to the first network node;

receive configuration information from the first network node with a second private user identifier and a second public user identifier, the second private user identifier and second public user identifier being associated with a second network node; and

register with a third network node using the second private user identifier and the second public user identifier,

wherein the first network node is a first mission critical push to talk (MCPTT) server, the second network node is a second MCPTT server, and the third network node is a serving call session control function (S-CSCF.

15. A method at first network node configured for authentication between a user equipment and a third network node using an internet protocol (IP) multimedia subsystem (IMS), the method comprising:

establishing a tunnel with the user equipment;

authenticating a first public identity of the user equipment at first network node;

receiving a configuration information message from the user equipment, the configuration information message including a network identifier for a network the user equipment is registered on;

obtaining, from a second network node, a second private user identifier and second public user identifier; and

providing the second private user identifier and second public user identifier to the user equipment,

wherein the first network node is a first mission critical push to talk (MCPTT) server, the second network node is a second MCPTT server, and the third network node is a serving call session control function (S-CSCF).

16. The method of claim **15**, wherein the establishing uses a certificate requested by the user equipment.

17. The method of claim **16**, wherein the certificate is created based on an identifier at the user equipment.

18. The method of claim **17**, wherein the identifier is one of a device identifier or a private user identifier from a universal integrated circuit card on the user equipment.

19. The method of claim **17**, wherein the identifier is stored in a mobile equipment (ME) of the user equipment.

20. The method of claim **15**, wherein the authenticating includes receiving from the user equipment at the first network node at least one of a device identifier or a network the UE is registered on.

21. A first network node configured for authentication between a user equipment and a third network node using an internet protocol (IP) multimedia subsystem (IMS) the first network node comprising:

a processor; and

a communications subsystem,

wherein the first network node is configured to:

establish a tunnel with the user equipment;

authenticate a first public identity of the user equipment at first network node;

receive a configuration information message from the user equipment, the configuration information message including a network identifier for a network the user equipment is registered on;

obtain, from a second network node, a second private user identifier and second public user identifier; and

provide the second private user identifier and second public user identifier to the user equipment,

wherein the first network node is a first mission critical push to talk (MCPTT) server, the second network node is a second MCPTT server, and the third network node is a serving call session control function (S-CSCF).

* * * * *